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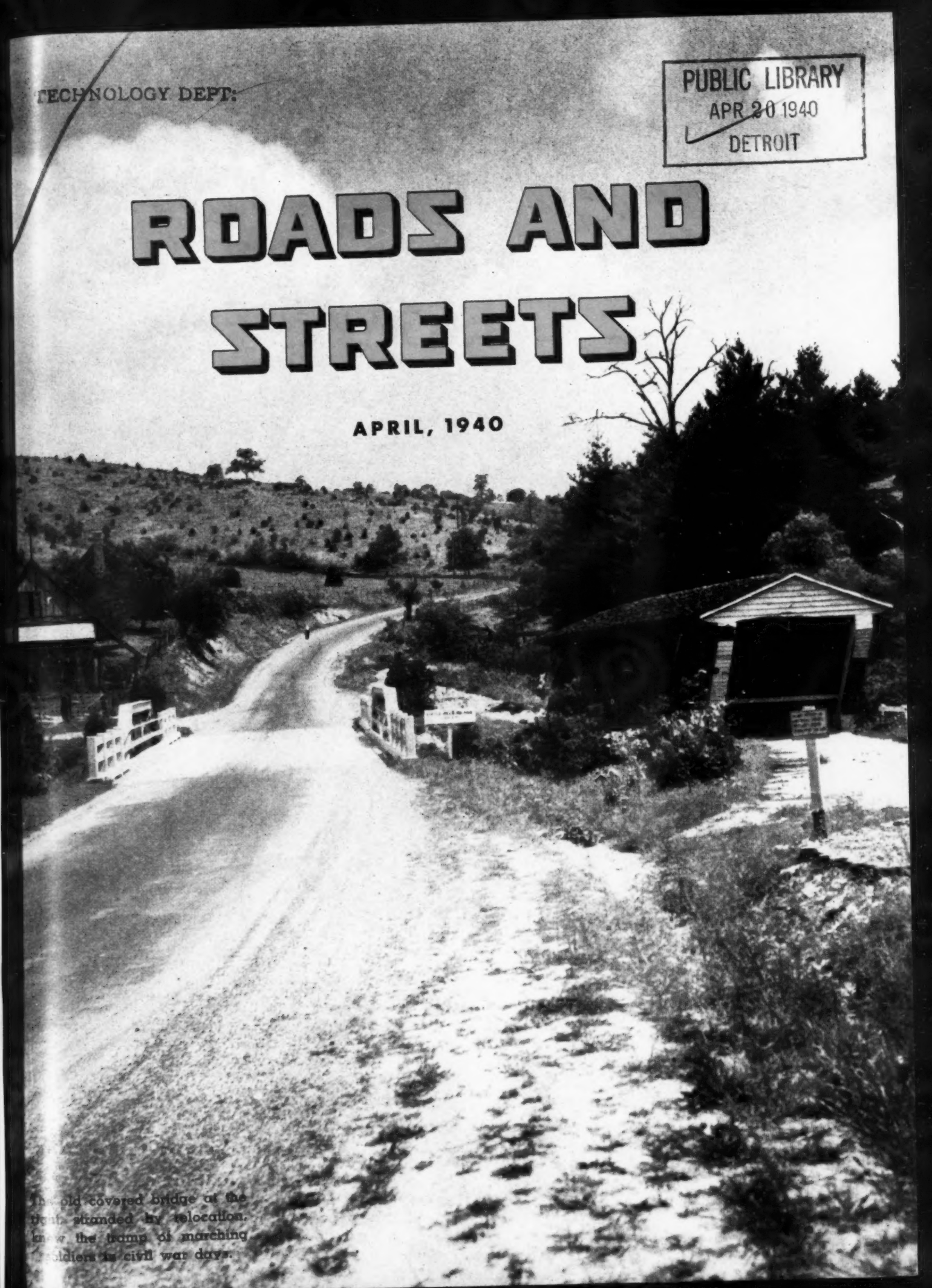

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ROADS and STREETS

Vol. 83, No. 4 April, 1940

A GILLETTE PUBLICATION
ESTABLISHED 1906

OHIO'S FIRST CLOVERLEAF

Grading Operations on Highway Project in Cuyahoga County

By T. J. KAUER*

Project Engineer, State Highway Department

ON JULY 22, 1938, the Ohio State Highway Department received bids for the construction of the first "Cloverleaf" in the state, which is located in Cuyahoga County about 7 miles southeast of the Cleveland Public Square on U. S. Route 21 at the intersection of State Route 17.

Work Let in Four Contracts

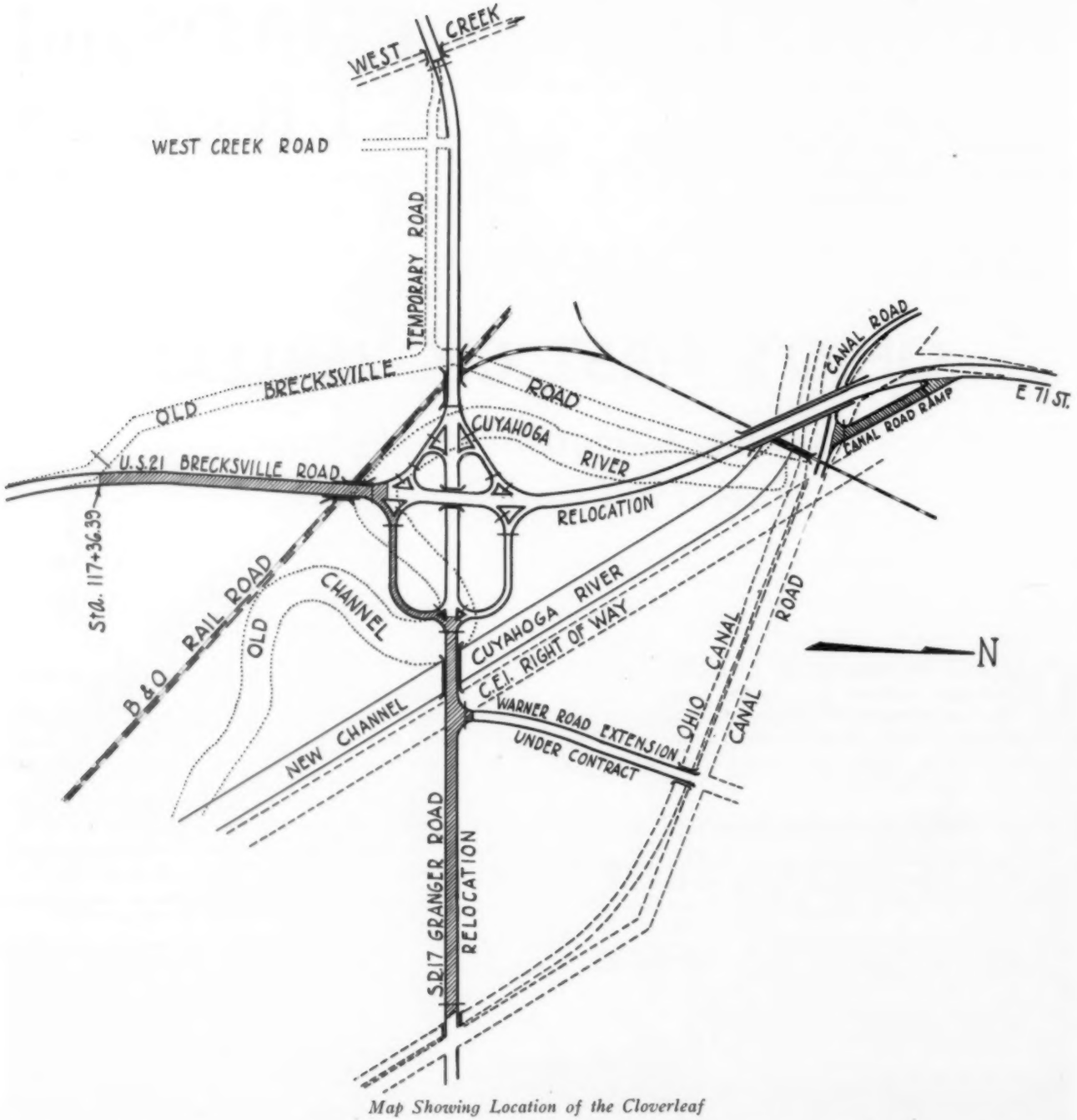
The project was estimated to cost $1,727,005 and was separated into four proposals; giving the contractors an opportunity to bid on any proposal or combination of proposals. The low bids on which the awards were made were as follows:

Proposal No. 1—for pavement on the entire project and drainage and sewers on one mile of U. S. 21 south of the "Cloverleaf"; awarded to The Baldwin Brothers Co., Cleveland, O., at $362,331.

Proposal No. 2—for all roadway excavation, embankment, Cuyahoga River diversion, drainage, and a 54 ft. span reinforced concrete rigid frame (mod.) stone faced highway grade separation structure on U. S. 21 over

* In collaboration with J. P. Ronan, Superintendent of Construction for The Herkner Construction Co., Cleveland, O.

New Channel of Cuyahoga River with Continuous Girder Bridge on S.R. 17 in Background, and U.S. 21 Embankment on Right



Map Showing Location of the Cloverleaf

State route 17; awarded to The Newhall-Herkner Construction Co., Cleveland, O., at $695,465.

Proposal No. 3—for construction of two bridges; a 3-span 227 ft. (64-99-64) reinforced concrete bridge with continuous steel girders, over the Cuyahoga River on State route 17; and a 5-span 583 ft. (100-125-125-125-108) reinforced concrete bridge with continuous steel deck plate girders, over the Cuyahoga River, Ohio Canal, Baltimore & Ohio R. R., and Canal Road over U. S. 21; awarded to The Hunkin-Conkey Construction Co., Cleveland, O., at $363,896.

Proposal No. 4—for construction of two bridges; a 3-span 227 ft. (64-99-64) reinforced concrete bridge with continuous steel girders, over The Baltimore & Ohio R. R. on State route 17; and a 3-span 195 ft. (60-75-60) reinforced concrete bridge with continuous steel beams, over the Baltimore & Ohio R. R. on U. S. 21; awarded to The Hunkin-Conkey Construction Co., Cleveland, O., at $155,318.

The awards of the contracts for the four proposals totaled $1,577,011, or approximately $150,000 below the engineers' estimates.

The state of Ohio and Cuyahoga County cooperated in the acquisition of property for the improvement, the construction of which was financed with state and regular Federal Aid funds, and Federal Aid grade crossing funds.

Actual construction was started on Aug. 19, 1938, and although scheduled for completion during 1939, is now 90 per cent complete and the final completion will be in September, 1940.

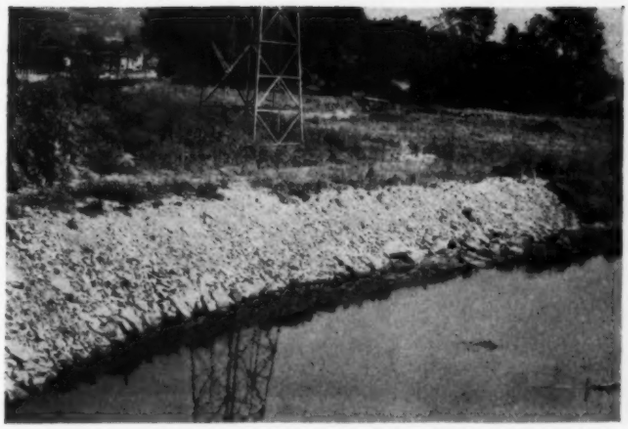
Diversion of Cuyahoga River

The construction of this project required the closest cooperation between the three contractors, all working

in the same area at the same time. The first major work to be performed was the diversion of the Cuyahoga River for a distance of 3000 ft. The old channel was required to be filled; however, not until an adequate waterway for diversion was constructed. One end of each of the two railroad grade separation structures is founded in the old channel of the Cuyahoga River, and the following construction procedure was necessary:

1st—70 ft. of the 120 ft. new river channel had to be completed for diversion.
2nd—The old river channel had to be filled in layers, thoroughly compacted.
3rd—Piling was then driven for the two bridge abutments, and abutment pedestals constructed.
4th—Roadway embankment was then placed around the pedestals of the spill-through type abutments.
5th—The pedestal caps were constructed.
6th—Embankment placed to full heighth of the fill.
7th—Bridge deck placed.
8th—Approach slabs constructed.
9th—Brick pavement placed.

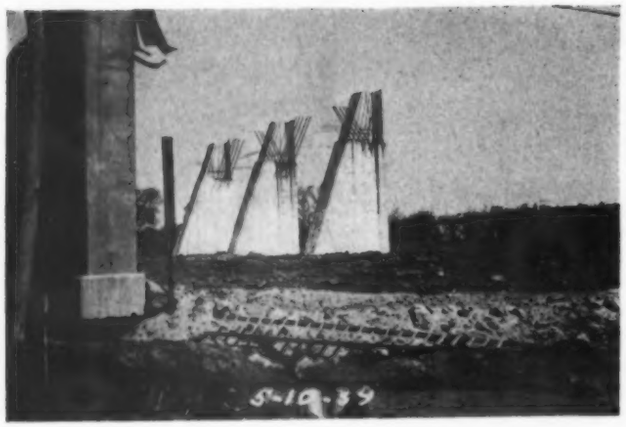
The river channel excavation amounting to 208,800 cu. yds. was performed by a sequence of operations; using three 12-yd. Austin-Western self-loading hydraulic scrapers, or scoops, for stripping, and excavating to a 2 to 3 ft. depth. These were followed by two 1½-yd. Lorain shovels excavating 6 to 7 ft. to the water table. The wet excavation was removed by two 1¼-yd. Lorain draglines operated from the banks, cutting an average of 8 ft.



Dumped Rock Fill for River Bank Protection

A 70-ft. channel was cut first to permit diversion, which necessitated the stock-piling of about 75 per cent of the excavation. bout a fourth of the excavation was cast and the balance hauled either to stock-piles, embankment, or waste areas with 12-yd. La-Plant-Choate track-wagons towed with RD 8 diesel powered Caterpillar tractors, and 8-yd. Euclid Trac-trucs, with the

Construction View of Cuyahoga County Cloverleaf Taken on Nov. 9, 1939 **Butler Airphoto**

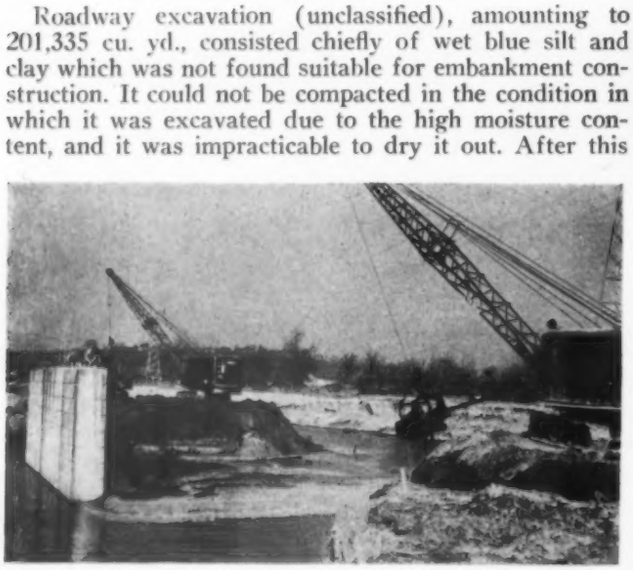


Pedestals of Spill-Through Type Abutment Ready for Embankment

Euclids hauling from the shovels and the track-wagons from the draglines. As work on the project extended to other operations, several units of the equipment noted above were pulled off the channel work. However, with all this equipment working at one time a 6,000 cu. yd. per shift production was possible.

Roadway Excavation

Roadway excavation (unclassified), amounting to 201,335 cu. yd., consisted chiefly of wet blue silt and clay which was not found suitable for embankment construction. It could not be compacted in the condition in which it was excavated due to the high moisture content, and it was impracticable to dry it out. After this



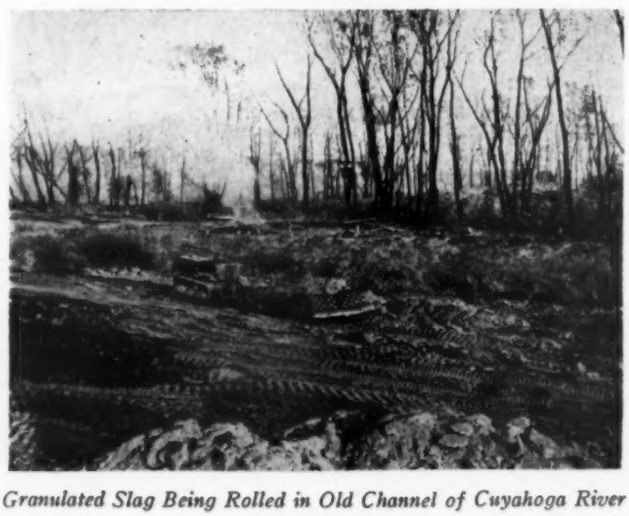
Draglines Excavating New River Channel at Bridge Location on S.R. 17

material was spread evenly in 8-in. layers, it was rolled once with sheeps-foot rollers in tandem, and then a layer of granular material driven into it, absorbing some of the water and making a mixture which would compact. Although both 12-yd. self-loading scrapers and 1½-yd. shovels were used in this excavation, it was found that such material excavated in thin layers with the scrapers could be more easily spread. As this material came from a hill at the south end of the project, the scrapers could reach the summit by using a circuitous route and load going down grade. After the shovel excavation started, the scrapers were used on the outer rim of the hill and were able to maintain suitable roadways for the trucks. After rains, the tractor drawn scrapers were exceedingly useful in removing the wet film or layer of earth on all roadways so that the rubber-tired hauling equipment could operate more easily.

Channel embankment, amounting to 100,000 cu. yd., was placed immediately after the Cuyahoga River diversion using broken brick-bats from a nearby abandaned brick plant, and granulated slag in the bottom of the old river channel to form a stable foundation. The balance of the channel embankment to the floor of the valley was constructed with alternate layers of channel excavation and borrow material.

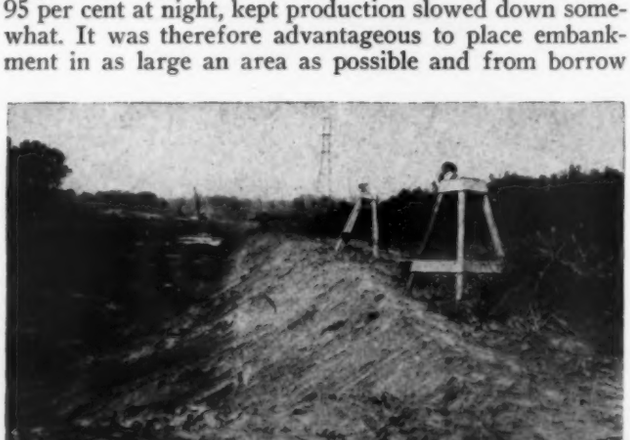
Roadway Embankment

The roadway embankment, amounting to 781,229 cu. yd., was constructed of material from the roadway excavation and four borrow pits. All embankment was paid for measured in place, no borrow pit measurements being necessary. The scrapers were used in conjunction with 1½-yd. shovels from the excavation and adjacent



Granulated Slag Being Rolled in Old Channel of Cuyahoga River

borrow pits. A total of three 12-yd. scrapers, four 1½-yd. shovels, twelve 8-yd. trac-trucs, and eight 5-yd. White trucks were used in furnishing the major part of the embankment material with an average haul of approximately 4,500 ft. and producing an average of 5,000 cu. yd. per shift. Two and three shifts were operated continuously from Sept. 1, 1938 to Nov. 30, 1938, and from May 1, 1939 to Nov. 30, 1939 on a 5-day basis. All equipment was operated with lights at night in addition to portable flood lights on the embankment area. High humidity in the valley, nearly always reaching 95 per cent at night, kept production slowed down somewhat. It was therefore advantageous to place embankment in as large an area as possible and from borrow



70-Ft. River Channel Excavation Completed to Water Table with 1½-Yd. Shovels

Equipment Used in Grading Operations

pits which did not require the hauling on public traveled roads.

No water was needed to obtain maximum compaction except on areas left open for the hauling roads which became very dusty during the hot weather; and for the granulated slag blanket. Granulated slag was specified on the lower 4 ft. of all embankment 6½ ft. or more in height to overcome the unsatisfactory and unstable condition of the valley floor which was practically pure silt. As the granulated slag becomes very hard within a short time due to self-cementation, it also offers a safeguard against the ravages of flood water which frequently covers the valley.

The granulated slag was furnished by the Cleveland Slag Co. at the rate of 2,000 to 3,000 cu. yd. per shift over a 5-mile haul. The slag was dumped on the embankment area as needed, and the larger lumps crushed by the tractors. After spreading, the slag was watered with water wagons at the rate of about 200 lb. of water per cu. yd. of slag, and thoroughly compacted with a sheeps-foot roller. The upper layer of granulated slag was always in a loose condition, with all compaction being secured in the layer immediately below. Embankment construction of such material can be carried on in all weather, year in and year out without interruption.

A 50 per cent silt limitation was placed on all borrow material going into embankment construction and in order to meet this, all shovel cuts ranged up to 20 to 24 ft. in height. This permitted a fairly uniform mixture of silt, clay, sand, and gravel. Usually the depth of the layer of sand and gravel, always found at the lower elevation of the cut and at the water table, was the determining factor of whether or not the silt limitation would be exceeded.

In one borrow pit, well above the valley, the water table was so high that it was necessary to make a shovel cut into the center of the area and around one side in order to lower it sufficiently to obtain enough sand and gravel to bring the mixture well within the silt limitation established in the contract.

Channel Slope Protection

Several portions of the new river channel were provided with protection for the slopes against erosion; the contract specifying 12-in. hand laid grouted stone riprap or 1:8 concrete in bags. The riprap construction was abandoned due to the sudden erosion of the river bank caused by the breaking off of large pieces of brown silt, 8 ft. in thickness, underlaid with fine sand which readily washes out by the action of the stream. In its stead, a 3-ft. thick dumped rock fill was substituted on the full height of the slope. This type of protection can easily be maintained, as erosion takes place, merely by adding more rock; whereas a thin section of the rigid type riprap would break and crumble as soon as the bank started to erode. In all 4,000 cu. yd. of rock were furnished for this bank protection, all of which was quarried by the contractor and placed during the winter of 1938-1939 when the ground was frozen, making easy access to the river's edge.

At the present time (March 1), only 35,00 cu. yd. of embankment has yet to be placed. This is located around both abutments of the rigid frame highway grade separation structure, and on East 71st St., north of continuous deck plate girder bridge now being completed by The Hunkin-Conkey Construction Co., and on which all superstructure concrete was placed under winter construction methods this year. Other work to be performed is the construction of the rigid frame bridge which is 55 per cent complete, and approximately 2 miles of brick pavement.

The operations of The Herkner Construction Co. on this project were under the supervision of J. P. Ronan, and with the guidance of their chief engineer, R. E. Stein. The work of the Hunkin-Conkey Construction Co. is under the supervision of Guy Conkey, Jr., with the assistance of William Hadde, Engineer. The paving by the Baldwin Brothers Co. is under the supervision of J. W. Johnson.

STANTON WALKER FELLOWSHIP

Dean S. S. Steinberg of the College of Engineering of the University of Maryland has announced the establishment at the university of the Stanton Walker Fellowship by the National Sand and Gravel Association. This fellowship, which amounts to $600 a year, will be for research on appropriate problems related to the sand and gravel industry. It has been named by the association for Stanton Walker, Director of Engineering Research for the organization during the past 14 years. Applications for this fellowship will be received up to May 1, 1940, and forms for this purpose may be secured by writing to the Dean of the Graduate School, University of Maryland, College Park, Md.

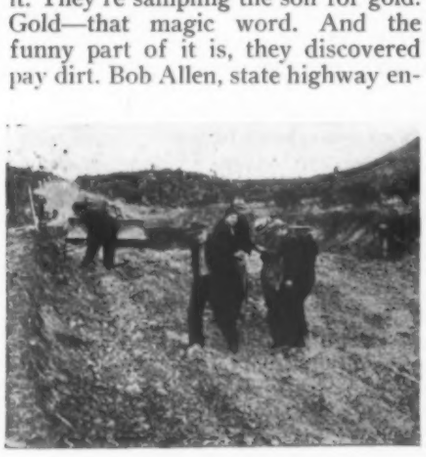
OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ On a construction job near Searchlight, in Clark County, Nevada, a contractor found digging so tough he used a rooting plow. The top photo shows the rooter at work. In the bottom photo you would say, if asked, that those fellows were taking soil samples for testing. In the words of Prof. Quiz, I would answer—correct! Absolutely correct!

But the sampling is not the kind

you think might occur on a road job. Note the fellows with picks on the left and right. Now you've guessed it. They're sampling the soil for gold. Gold—that magic word. And the funny part of it is, they discovered pay dirt. Bob Allen, state highway engineer, told me it ran 39 cents a ton. In this case the state turned prospector. The road was built as planned with miners digging on the sides and underneath.



• •

¶ My idea of what a sensible highway speed law should be I copied below from the back of Nevada's official road map. It is:

Speed Limit—It is unlawful to drive a motor vehicle at a rate of speed greater than that which is reasonable and proper, having due regard for traffic, surface and width of highway.

Slow moving traffic shall drive to the extreme right of the highway, but in no place shall drive at such a rate of speed that it will delay or hinder the traffic in the rear beyond a reasonable limit.

• •

¶ The worst punishment a speaker can inflict on his audience is to read a paper in such a low voice that nobody can hear him, or to fill it with statistical data and figures which he reads off. I don't blame some of those engineers for taking a short nap occasionally at Prof. Diefendorf's Road School at the University of Utah recently. It would be a dirty trick to name names.

• •

¶ Conversation between "Maury" Housecroft, bridge engineer for Utah State Road Commission and Assistant State Highway Engineer Moffat:

Maury—Have you heard the latest "What Confucious Say?"

Moffat—No.

Maury—Darn it, neither have I.

• •

¶ Unscrewing rod on inside of foundation test drill. Rope pulled

end-wise tightly unscrews the rod. Loosening the rope and pulling back gets a new grip for next rapid unscrewing.

• •

¶ You know, I got a kick out of that Road School at the University of Utah. While a bunch of highway engineers were learnedly discussing traffic safety, a cop was leisurely tagging their cars for violating the city's traffic laws. Pretty good, eh?

• •

¶ You know it's been said that Columbus was the greatest politician that ever lived. When he started out he didn't know where he was going. When he got there he didn't know where he was. When he got back he didn't know where he'd been. And he did it all on borrowed money. I heard it over station KSL in Salt Lake City, Utah, and I couldn't help but think that's the way Prof. Diefendorf must have felt about those

traffic tickets he tried to fix for the engineers who attended his first Highway Engineering Road School at the University of Utah the second week of March.

• •

¶ Speaking of titles, what kind of a school is one that is Highway Engineering Road?

• •

¶ When it comes to attending one of those Sunday school classes with Utah Road Commission engineers where the four kings are discussed, with deuces wild, be sure to play 'em close. A. P. J. made his contribution.

• •

¶ Hanging in the office of Cote Equipment Co. at Salt Lake City, Utah, is the following:

A man has two ends—
He sits on one and thinks with the other.
The success which he attains, depends upon which end he uses most.

• •

¶ Colorado highway department employees are eating again. They finally got their February pay checks.

• •

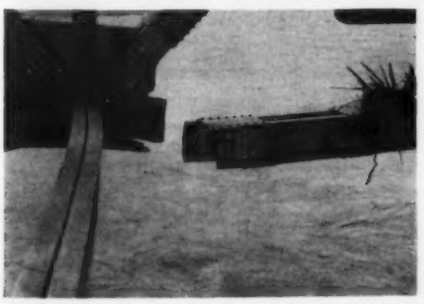
¶ Talking about moving along, you should drive over the rebuilt U. S. 30 in Wyoming. In another year that route will be rebuilt clear across the state, nice and wide, with easy curves and grades. Good work, Wyoming. I presume the politicians would like to spread the money around the state. But U. S. 30 is the earner and certainly should be completed to that high standard.

• •

¶ Came over Donner Pass, U. S. 40, into California on a practically dry pavement. Chains were required in the morning. That shows how the State of California keeps on the snow removal job.

• •

¶ Damage to Trinity River bridge, Douglas City, Trinity County. Detail of broken member L_2L_4 of upstream truss of span 5. This truss was struck



by a ranging gold barge during the flood of the last week of February and first week of March. The truss is a bottom chord and the picture illustrates a point that a field editor of ROADS AND STREETS maintains. It is: "We are building uneconomic structures. Too much strength is being built into them." This bridge is standing with a bottom chord completely severed.

• •

¶ When the railroad grade separation problem in a state was well in hand, even before the federal grade separation appropriations were made, the state naturally has less deaths and accidents at grade crossings than it has on crooked, narrow, secondary roads. It seems, therefore, if it could be worked out without jeopardizing the whole grade separation program of the federal government, that some discretion should be allowed the state as to whether those funds should be spent on unimportant grade crossing eliminations or on construction of important secondary roads.

• •

¶ Flood damage to north approach of Scotia bridge over the Eel River

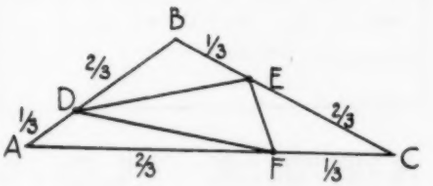
in northern California, resulting from heavy rains of Feb. 25 to 29.

• •

¶ J. N. S. from Springfield, Mo., wrote the California Division of Highways bridge department asking if it was true that a dog trotting over Golden Gate Bridge would cause it to collapse. He suggested that to protect it a rule be enforced requiring that dogs be carried in arms across the bridge or be carried in an automobile.

"Pan" is taking the reply under advisement.

¶ Herewith a problem taken from an entrance examination to the California Institute of Technology.



Area of triangle ABC = 1

Area of triangle DEF = ?

How many of you practicing executive engineers can work this?

• •

¶ There's one point in federal procedure about which I do not know as much, probably as I should. Perhaps you know. If so the following will be interesting and you probably know how to handle the situation:

At each Congressional session the appropriations for the forthcoming fiscal year in regard to highway construction are considered. The 1941 funds were authorized under the Hayden-Cartwright Act and the authorizations have been apportioned to the states. It is a contractual obligation, or promise to pay, on the part of the federal government. The authorization delegates the government to make appropriations to carry out these contractual obligations. All of the states proceed with their highway program planning and budgeting on that basis. At present there is much concern about this matter that can be simply exemplified by quoting a statement in regard to the forest highway appropriations:

"The Budget Bureau recommended an appropriation of $10,000,000 and Congress has recommended reducing this amount by $2,500,000, which should leave a possible $7,500,000 as the total of the cash appropriation."

The authorization for this item was for $13,000,000.

Now what I don't understand is how the Budget Bureau can recommend any less amount than the obligation contracted by Congress in the form of an authorization. And further, what right has Congress to appropriate less than they authorized? Looks like funny monkey business to me.

• •

¶ A. P. J. just learned that he has so many women readers—wives of engineers and contractors, of course—that he has decided to devote one issue to these regular guys. This is the suggestion of one of his feminine readers.

A four-mile stretch of the Trail Ridge road in Colorado is at an altitude of more than 12,000 feet above sea level.

American Road

WASHINGTON, D. C.

ARBA ANNUAL SPRING MEET

The annual spring business meeting of the American Road Builders' Association will be staged in Washington, D. C., May 8-10. The newly elected ARBA president will be honored at the President's Dinner at the Willard hotel on May 9. Other new officers of the ARBA and its various divisions will also be installed during this conclave and retiring officials will make their reports. Entertainment feature of the meeting will be the annual ARBA Golf Tournament on May 8. Low-net winner will have his name inscribed on the permanent Road Builders' Golf Trophy, on display in the association offices, and will receive a duplicate of the cup for his permanent possession. Numerous prizes are also being donated by ARBA manufacturer members.

Down the Road

by **CHARLES M. UPHAM**
Engineer-Director,
American Road Builders' Association, Washington, D. C.

READIN', 'RITIN', 'RITHMETIC AND RURAL ROADS

The little red schoolhouse is no more. Subject for homesick tales, the old-fashioned rural school is reviewed through time's romantic mist. Psychologists assert that it is man's way to remember happy moments, forget unpleasant ones. Those of us who attend little red schoolhouses are likely to remember schooldays as perpetual spring days. Playin' hookey, goin' fishin', dippin' pigtails in inkwells, baseball at recess, rasslin', swimmin', the three "Rs" blend in panoramic, reminiscent, pleasant blur.

But the materialists among us are inclined to remember less whimsical details. Trudging meandering miles, wading, sloshing through snow, mud, slush and ice to an inadequately heated little red schoolhouse. Returning home in the chill of late afternoon, sniffling and sneezing. One harassed, non-too-proficient school "marm" teaching all and unkindred subjects. Heat and cold and rain and monotony. We are glad that our young Betty and our young John are not forced to undergo those old-fashioned hardships of education.

The schoolbus and the improved rural road brought about a radical change for the better in the philosophy and technique of rural education. Most farm folk are provided with educational opportunities and advantages no different from that of their urban neighbors. Most, but by no means all. For the distressing fact remains that 60 per cent of the nation's rural families, even in this enlightened and progressive American year of 1940, still live on unimproved dirt roads, often untraversable in bad weather. It is reassuring to realize, however, that all highway agencies of federal, state and county government are planning and studying in a co-operative effort to alleviate the ill condition of our secondary road system. Highway organizations like the American Road Builders' Association combine various divisions of the highway industry and profession into an efficiently working research unit, devoted to solving rural and other national road problems.

Despite the banishment of the little red schoolhouse, is the American system of public education as effective as it should be? I don't propose to answer that question. My profession is engineering, not education. But it is a problem that increasingly becomes a subject of heated debate. "The arts," cries one faction. "The trades," cries another. The question is born of an ominous factor in our national life. Between the ages of 15 and 24, there are 4,000,000 American youths unemployed and looking for jobs. Is a faulty process of public education partly responsible for this condition? That's for the educators to answer. But one fact is obvious. Without popular education, the number of unemployed young people would be much higher.

Virtually every job nowadays requires knowledge, at least of reading, writing and simple arithmetic. The effectiveness of popular education in eliminating illiteracy is testified to by a revised phase of the 1940 national census. The census query involving illiteracy has been abolished. Those who never learned to read and write form an infinitesimal portion of our population and the question is no longer deemed justified. And the progress of America's rural education parallels without deviation the progress of America's rural road development!

WILLIAM CULLIMORE NAMED PAVING BRICK SECRETARY

William H. Cullimore was recently named engineer and secretary of the National Paving Brick Association to succeed the late George F. Schlesinger, ARBA

treasurer. Mr. Cullimore, an active member of the American Road Builders' Association, resigned as associate engineer of the Baltimore, Md., department of public works to accept his present position. He has also been associated with the Baltimore paving commission, the Greensboro, N. C., highway department and the Baltimore bureau of sewers.

Builders' Review

APRIL, 1940

There are more than 2,000 distinguishable parts, composed of 15,000 pieces, in every automobile.

SCHEDULED FOR MAY 8, 9, 10

With Our State Groups

MICHIGAN

ARBA President and Michigan State Highway Commissioner Murray D. Van Wagoner addressed the annual Highway Conference in Ann Arbor, sponsored by the Michigan Association of Road Commissioners and Engineers. Founder members who attended the first conference in 1915 were honor guests. Leon Luke, engineer, Macomb County Road Commission, was elected president of the group.

MINNESOTA

S. S. Daniels, president, Crookston Association of Public Affairs, was elected president of the Minnesota Section, Northwest Good Roads Association, at the annual board of governors meeting in Minneapolis. Other officers are Mark Nolan, district judge of Duluth, first-vice president; Art Nachriener, Rochester, second vice-president, and E. W. Moeller, executive secretary, Minnesota Highway Development Association, an ARBA affiliate, secretary. The association resolved to renew its efforts in support of re-enactment of the 4-cent gas tax in the 1941 session of the legislature.

NEW HAMPSHIRE

The annual meeting of the New Hampshire Good Roads Association was held at Concord, March 13-14. David L. Fosburgh, secretary of the ARBA affiliate, was in charge of arrangements for the annual banquet at the Eagle hotel.

TEXAS

Anti-diversion resolutions were adopted at the recent annual meeting of the Texas Good Roads Association. The ARBA affiliate resolved to petition the legislature to submit to the people a constitutional amendment prohibiting the use of highway taxes for non-highway purposes. Another resolution urges that Congress appropriate for federal-aid highways at least the total amount of taxes collected directly from the highway user.

At NBC microphone, left to right above, are ARBA Engineer-Director Charles M. Upham, House Roads Committee Chairman Wilburn Cartwright and Roads Committee Ranking Minority Member Jesse P. Wolcott.

UPHAM, CARTWRIGHT AND WOLCOTT SPEAK ON NBC

ARBA Engineer-Director Charles M. Upham interviewed Oklahoma Congressman Wilburn Cartwright and Michigan Congressman Jesse P. Wolcott in a nationwide broadcast, March 22. The three highway authorities discussed "Roads and the National Economy" over the NBC Red network. Representatives Cartwright and Wolcott, chairman and ranking minority member, respectively, of the U. S. House Roads Committee, explained the federal highway program, with particular emphasis on pending legislation to continue federal aid for the fiscal years 1942 and 1943. Mr. Upham outlined America's road needs and the improvements needed to bring our highway system up to date.

HIGHWAY ENGINEERS MEET IN NEW YORK

The New York State Association of Highway Engineers held its fifth annual convention in Rochester, March 28-30. Speakers included U. S. Senator James M. Mead of New York, a member of the Senate Committee on Post Offices and Post Roads, on roads from the national viewpoint and Robert E. Harper, ARBA director of public relations, on "Selling Good Roads to the Public." Preceding his convention speech, Mr. Harper spoke over Rochester Station WSAY on "What Do You Know About Roads?"

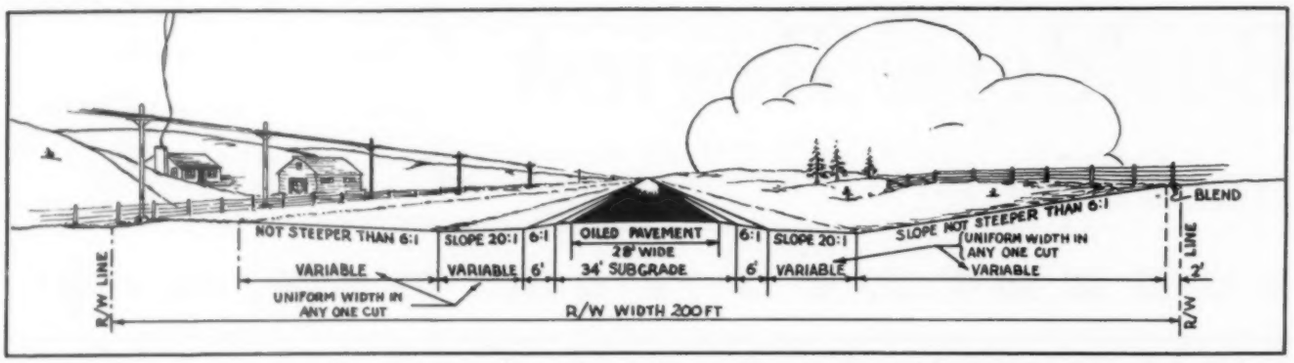


Fig. 1.—Standard Streamlined Airflow Cross-Section Design Used by the Wyoming State Highway Department on Primary Roads. Airflow or Streamlined Design on Both Cuts and Fills Keeps Roads Free of Snow and Reduces Maintenance Costs

EMBANKMENT DENSITIES

Increase in Wyoming with Increased Size of Grading Equipment

By C. F. SEIFRIED
Office Engineer
Wyoming State Highway Department

IMPROVEMENT of Wyoming's most heavily traveled through-highways has been a work of second major importance. Of primary importance, along with the improvement of farm-to-market roads, has been the improvement of long mileages of mountain roads to eliminate the dust problem. These roads are on direct routes to and through the scenic attractions of the state. Several hundred miles of low type surface treatment have been completed during the past construction season and it is planned to continue this program with the opening of spring work.

In general, this work consists of shaping the present grade which, usually, contains some gravel or crushed rock. It is then watered and rolled to a compact surface. On the rolled surface is spread a penetration coat of medium curing asphalt. When this has penetrated, an application of rapid curing asphalt is applied and immediately covered with coarse sand or fine stone chips. The result is a dustless surface suitable for light tourist traffic using the roads during the summer months.

Heavier Construction

Wyoming's most traveled road is U. S. 30, east and west across the state. Due to this fact, it is only natural that this road should be given improvement priority to a fairly high standard. Completed, or under contract are 118 miles between Rawlins and Rock Springs. From Rawlins west about 20 miles, J. J. Dooling of Denver has a grading section. Blanchard Brothers of Cheyenne are building the bridges. On the next 20 miles, to Wamsutter, the grading has been completed and the Inland Construction Co. of Omaha is placing the base course. From Wamsutter west to within about five miles of Rock Springs, the new work has been completed. There is a short stretch of oiling yet to be done just east of Rock Springs by J. C. Compton & Co. of McMinnville, Ore.

Grading

The cross-section view shown in Fig. 1 gives a general idea of the road section. Grading is carried out on very flat slopes in order that blowing snow will not drift on the surface. The cross-section is "streamlined." No grades are over 6 per cent and no curves are over 3 degrees, and all are spiraled. The completed section between Wamsutter and Rock Springs crosses the Continental Divide at an elevation of 7,178 ft. This is the first section of a continuing stretch westward and the entire section is above an elevation of 6,000 ft.

One of the features of the new grading is the 6-1 side-slope, as shown in Fig. 2, with wide, flat borrow pits alongside. In laying the grade line, particular study is given to wind and snow conditions. With the so-called "streamlined" section, it is found, especially in prairie countries, that the grade line can be held considerably lower with this type of cross-section than with one calling for steeper slopes. By January 1943 it is expected that the entire route across the state will have been built to the new high standard.

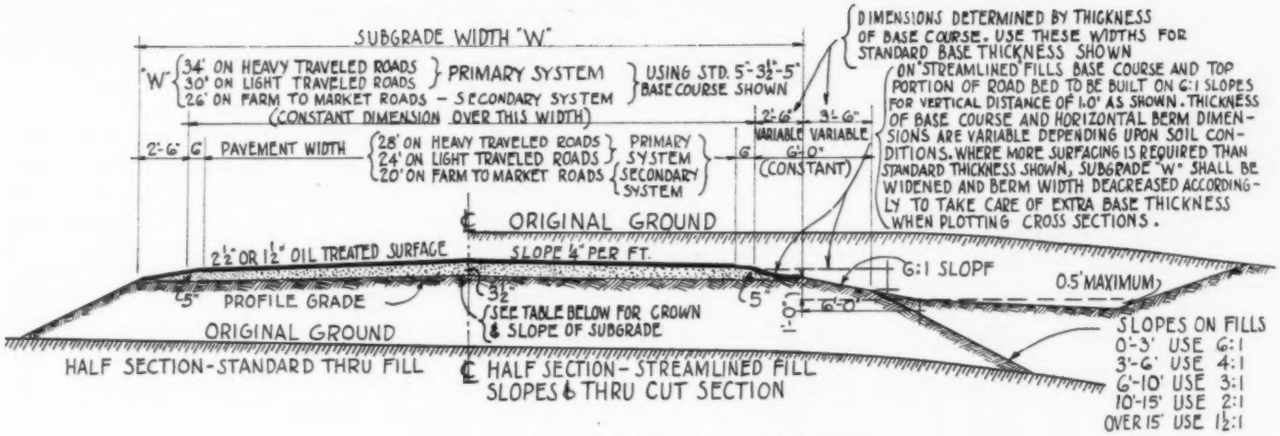

SUBGRADE WIDTH "W"
"W" 34' ON HEAVY TRAVELED ROADS / 30' ON LIGHT TRAVELED ROADS } PRIMARY SYSTEM
26' ON FARM TO MARKET ROADS – SECONDARY SYSTEM
(CONSTANT DIMENSION OVER THIS WIDTH)
USING STD. 5"-3½"-5" BASE COURSE SHOWN
2'-6" G PAVEMENT WIDTH
28' ON HEAVY TRAVELED ROADS / 24' ON LIGHT TRAVELED ROADS } PRIMARY SYSTEM
20' ON FARM TO MARKET ROADS } SECONDARY SYSTEM
2'-6" VARIABLE
3'-6" VARIABLE
G 6'-0" (CONSTANT)
℄ ORIGINAL GROUND
2½" OR 1½" OIL TREATED SURFACE
SLOPE ¼" PER FT.
5" PROFILE GRADE
3½"
SEE TABLE BELOW FOR CROWN & SLOPE OF SUBGRADE
5"
6'-0"
G:1 SLOPE
0.5' MAXIMUM)
ORIGINAL GROUND
HALF SECTION-STANDARD THRU FILL
℄ HALF SECTION-STREAMLINED FILL SLOPES & THRU CUT SECTION
DIMENSIONS DETERMINED BY THICKNESS OF BASE COURSE. USE THESE WIDTHS FOR STANDARD BASE THICKNESS SHOWN
ON STREAMLINED FILLS BASE COURSE AND TOP PORTION OF ROAD BED TO BE BUILT ON G:1 SLOPES FOR VERTICAL DISTANCE OF 1.0' AS SHOWN. THICKNESS OF BASE COURSE AND HORIZONTAL BERM DIMENSIONS ARE VARIABLE DEPENDING UPON SOIL CONDITIONS. WHERE MORE SURFACING IS REQUIRED THAN STANDARD THICKNESS SHOWN, SUBGRADE "W" SHALL BE WIDENED AND BERM WIDTH DECREASED ACCORDINGLY TO TAKE CARE OF EXTRA BASE THICKNESS WHEN PLOTTING CROSS SECTIONS.
SLOPES ON FILLS
0'-3' USE G:1
3'-6' USE 4:1
6'-10' USE 3:1
10'-15' USE 2:1
OVER 15' USE 1½:1

Fig. 2—Typical Roadway Section

Subgrade Width "W" in Feet	Crown in Inches	Slope on Subgrade Inches per Foot
34	6.00	0.353+
30	5.55	0.37
26	5.10	0.392+

A special prospecting machine which closely follows the design of the one worked out last year by Mr. O. J. Porter of the Division of Research and Tests, of the California Department of Highways, was used to obtain core information on the soil formations to be encountered. Not only are bridge foundations being more carefully explored with this outfit which they mounted on a 4-ton truck chassis, but complete tests are being provided for contractors bidding on the work. Ten contractors know the exact nature of all excavation they must handle.

In addition, soil samples along the line are tested in the laboratory and maximum densities to be obtained on construction are determined. Ninety to 100 per cent of the maximum density with optimium moisture content is obtained on construction and improvement on this is expected during the next season.

Shrinkage on Grading Jobs

Table I shows some interesting data relative to compaction. It applies to all work done in Wyoming during the period Jan. 1, 1939, to Jan. 1, 1940, and not particularly to the Rawlins-Rock Springs work. The projects have been grouped according to the shrinkage which actually occurred on the job. Study of this grouping showed that soil conditions, as well as the character of the terrain, were, in general, the same. While there is some variation on the individual jobs, soil conditions are, in general, similar throughout each job. By studying this table and knowing the soil conditions on the new job to be designed, the engineer is enabled to make a closer approximation of the amount of the percentage of shrinkage to allow on the job he is designing. Rolling with optimum water content is included and the shrinkage factor shows the density with respect to the original soil volume. For example, on U. S. 87, Sheridan-Big Horn road, the first item, there were actually 135,416 cu. yd. of actual embankment placed, but it took 140,376 cu. yd. of actual excavation to build it. In this case only 3.66 per cent shrinkage occurred.

Table II shows the effect of modern heavy grading outfits on density as well as the effect of improved

TABLE I.—TABULATION SHOWING SHRINKAGE (ACTUAL MEASUREMENTS) OCCURRING ON GRADING JOBS COMPLETED DURING PERIOD JANUARY 1, 1939, TO JANUARY 1, 1940

Route	County	Road	Miles	Actual Exc.	Actual Emb.	Shrinkage	Remarks
U.S. 87	Sheridan	Sheridan-Big Horn	6.98	140,376	135,416	1.0366	
	Crook	Hulett-Carlisle Junct.	6.08	268.207	249,806	1.0736	
	Uinta	Urie-Carter	3.86	152,208	145,730	1.0444	Jobs on which
U.S. 30	Sweetwater	Rock Springs—Point of Rocks	11.93	438,793	399,091	1.0994	less than 10%
U.S. 14 and 16	Campbell	Gillette-Spotted Horse	10.88	359,663	332,315	1.0822	shrinkage occurred
U.S. 287	Fremont	Dubois-Diversion Dam	5.49	260,069	250,632	1.0377	
U.S. 20	Big Horn	Greybull Overhead	0.76	28,435	26,490	1.0734	
Subtotal			45.98	1,647,751	1,539,480	1.0703	= 3% of total yardage
	Goshen	Torrington-west	4.43	61,725	54,418	1.1342	
	Hot Springs	Cody-Thermopolis	6.11	198,214	179,567	1.1038	
	Hot Springs	Cody-Thermopolis	5.02	165,434	147,312	1.1230	Jobs on which
U.S. 30	Albany	Medicine Bow-Bosler	15.63	399,365	350,509	1.1394	10% to 15%
U.S. 30	Sweetwater	Wamsutter-Rawlins	20.00	448,041	406,533	1.1021	shrinkage occurred
U.S. 20	Converse	Casper-Glenrock	14.46	606,021	531,339	1.1405	
U.S. 30	Albany	Laramie-Bosler	8.34	210,661	186,936	1.1269	
Subtotal			73.99	2,089,461	1,856,614	1.1254	= 47% of total yardage
	Lincoln	LaBarge-Calpet	4.46	91,829	73,190	1.2546	Jobs on which
	Platte	Wheatland-West	3.85	62,426	51,274	1.2174	over 15%
	Washakie	Worland-South	3.72	61,113	44,879	1.3617	shrinkage occurred
U.S. 189	Lincoln	Kemmerer-LaBarge	17.46	469,092	400,629	1.1708	
Subtotal			29.49	684,460	569,972	1.2009	= 16% of total yardage
TOTALS			149.46	4,421,672	3,966,066		

TABLE II.—TABLE SHOWING INCREASE IN SHRINKAGE FACTORS

Completed	Miles	Actual Embankment	Actual Excavation	Cy Exc. Per Mile	Actual Shrinkage Factor	
Dec. 1932 to Sept. 1933	456	6,588,582	6,591,539	14,500	1.0000	
Sept. 1933 to Nov. 1934	254	3,381,250	3,457,066	13,600	1.0224	Changes to heavier equipment for grading.
Nov. 1934 to Feb. 1936	165	2,464,883	2,502,997	15,100	1.0154	
Feb. 1936 to Feb. 1937	215	4,587,900	4,856,376	22,600	1.0585	
Feb. 1937 to Nov. 1937	115	2,824,482	3,030,737	26,400	1.0730	
Nov. 1937 to Jan. 1939	205	4,985,642	5,485,088	26,700	1.1002	Soils testing and embankment construction control
Jan. 1939 to Aug. 1, 1939	33	839,709	925,785	28,100	1.1025	
Aug. 1, 1939 to Dec. 1, 1939	70	1,730,331	1,921,609	27,500	1.1105	
TOTALS	1,513	27,402,779	28,771,197	19,000		

The final grading quantities on the projects completed during the past seven years have been tabulated, added, and summarized in the above table.

This table does not necessarily include all of the projects that have been completed, but includes practically all of them. Thus, between December, 1932, and September, 1933, there were 456 miles of grading, involving 6,588,582 yards of embankment. The average shrinkage factor of this yardage was 1.0, and so on until during the period from August 1939 to December 1939, the average shrinkage factor as shown increased to 1.11.

This table shows the result of improved technique in constructing embankments, and also the influence of using heavier equipment in constructing the embankments.

All types of soil are represented in the total of 27,000,000 cubic yards, and the amount of rock, involving swell, is negligible, so far as these comparisons are concerned.

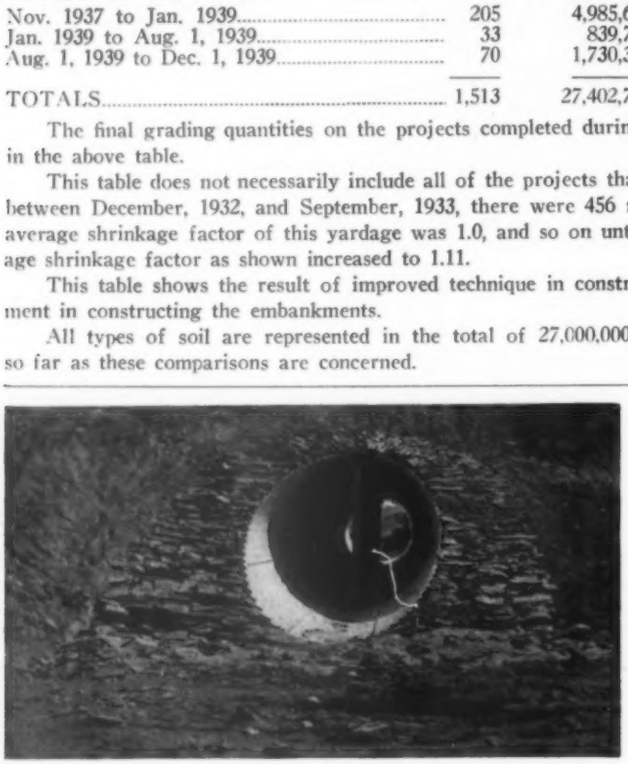


Fig. 3.—Prestressed Culvert with Rip Rap Protection and Cobbled Spillway

technique in the construction of embankments. From September, 1933, to November, 1937, the increaced densities obtained is attributed to the change to heavier grading units. From November, 1937, to December, 1939, soils tests and embankment control was applied during construction with an attendant increase in densities obtained.

Base Course

As indicated by Fig. 2, the subgrade width varies according to the volume and type of traffic expected. On the Rawlins-Rock Springs section it was made 36 ft. wide. On new construction, from 1½ in. to 18 in. of crushed or pit run gravel is placed and rolled. The reason for this variation in depth is the type of soil, the terrain, and other governing features. Before the depth of base course to be used is decided upon, samples of the material in the completed subgrade is taken. The usual tests, including plasticity index, liquit limit, are made on the material in the subgrade. By means of a table on which all the physical characteristics of the soil are shown, the depth of base surfacing to be used is tentatively decided upon. After this, a field inspection is made to make sure that the samples previously taken are representative, to study the performance of the roadway surface on old roads in the vicinity, and, in general, to make use of the experience the engineers have obtained during the past years of study of design and construction. Then, by a meeting of the practical experienced mind with the theoretical mind, the final determination of the thickness to be used is made. Great savings in base course surfacing material have been made by using this method.

Fig. 4.—Streamlined Roadway

Fig. 5.—Type of Low Cost Creosoted Timber and Pile Trestle Bridge Built by Wyoming. Roadway is 30 feet. Surface Course is carried Across the Laminated Floor

In general, local materials are used. 35 to 75 per cent of the material passing a No. 4 Laboratory sieve. Where necessary, the material is put through a crusher. In some cases it is necessary to waste fines and in other cases it is necessary to add minus 200 material. Considerable success has been obtained by these methods in getting a uniformly graded material, which is essential. Plasticity index of not more than six, and a liquid limit of not more than 25 on the fraction passing the No. 40 sieve is required.

On top of this base course, after a prime coat of MC-1 is applied, an oil mat 2 in. thick is placed by traveling bituminous mixing and proportioning plants. Mechanical screen tests are applied to the gravel to be

used for the base course to see that it falls within the aggregate density curve. On these tests the bituminous materials are proportioned.

Seal Coat. The surface treatment placed on the 2-in. mat is an RC-4 liquid asphalt over which crushed stone chips or pea gravel is spread. Referring to Fig. 2 it will be seen that the seal coat surface treatment is carried down over the edges of the base course. This is done in order to carry the waterproofing obtained by the film of MC-1 previously placed and the RC-4 placed in this operation as far as possible out away from the edge of the travelled way. The chips, or pea gravel, which constitute the actual wearing surface, are placed to a width of 24 ft. only. The 28-ft. paved surface is separated into two 14-ft. lanes by a yellow traffic line.

SCRAPERS MAKE 800 MILE OVERLAND TRIP

Ten Koehring highway model wheelers started on March 7th on what was probably the longest overland journey ever attempted by tractor-drawn scraper equipment. Rolling on 60 pneumatic tires valued at approximately $20,000, this fleet left the Parsons assembly plant of the Koehring Co. at Newton, Iowa, for a trip of approximately 800 miles over public highways. Their destination was Lamar, Colo. Their route passed through Iowa, Nebraska, Kansas and Colorado. Travel speed was 18 miles per hour. The Koehring Tractors are powered by General Motors 2-cycle 4-cylinder, 107 HP diesel engines.

Beginning of the Trek Westward by the Wheelercade.

This order was placed with the Koehring Co. by Western Contracting Corporation, Hubert Everist, President. The machines, after their westward tour, were placed in operation on Santa Fe R. R. relocation project around the site of Caddoa Dam near Lamar, Colo. About 22 miles of track are to be relocated, involving the moving of 3,500,000 cu. yds. of material. Seventy-five foot high fills will be built, 18 ft. across top. The material will be hauled up 7 per cent ramps. It is planned to operate three 8-hour shifts with nine wheelers and two push tractors, reserving one wheeler and one push tractor for replacement when servicing the operating fleet.

The weight of each wheeler is 24,700 lbs., and the width is 98 in. They were driven by the contractor's operators.

FORT PECK DAM SLIDE

The War Department has prepared a Report on the Slide of a Portion of the Upstream Face of the Fort Peck Dam, which is published by the United States Government Printing Office. The report is replete with pictures, diagrams, maps and drawings. It describes the slide which occurred September 22, 1938, on the upstream face of the dam near the east abutment and gives a summary of the investigations made, together with reconstruction plans and methods presented.

On page 7 appears the summary given below:

1. The upstream shell moved in mass, carrying the rock facing practically intact upon it.
2. A substantial portion of the trestles and pile bents buried in and under the upstream toe moved out intact.
3. The west part of the slide was limited to about station 27+00, 300 ft. short of the beam which had been previously placed from station 30+00 to the west.
4. The core material showed remarkable stability after being subjected to the rapid outwash of the core water.
5. The core pool at no time overtopped the shell.
6. The explorations made subsequent to the slide indicated distinct shear planes on or in the weathered portions of the shale foundation, and in the bentonite seams which lay, in general, horizontal within the shale, and which had a maximum thickness of approximately 15 inches.
7. Bentonite seams uncovered in exploratory tunnels and exploratory holes indicate this material to be saturated and, in some cases, under pressure.
8. Most of the fill materials involved in the slide show little change in stratification.
9. Shale on the right abutment moved down the A fault plane.
10. No shale movement is indicated east of fault A.
11. The upstream shell of the dam remained intact on the right abutment east of approximate station 10+00.

Asphalt Consumption at All Time High in 1939—At the annual meeting of the Board of Directors for the Asphalt Institute, Vice President A. M. Maxwell of Standard Oil Co. of Ohio, announced that figures for 1939 show asphalt consumption at 6,192,000 tons, an all time high, 7 per cent above the previous high record, made in 1938. Of this, 75% went into highways.

EXPANSION OF SIMPLE Y-TYPE INTERSECTION

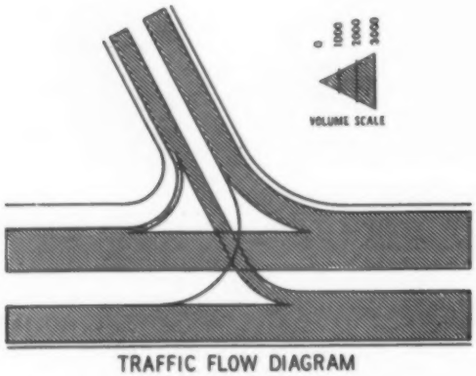
How a channelized intersection may be developed from a simple directional island costing around $300 to a more elaborate affair with signals at a total cost of several thousand dollars is described by L. A. Weymouth, Assistant Highway Engineer, Surveys and Plans, of the California Division of Highways in an article in the March issue of California Highways and Public Works.

Contrary to popular belief, a channelization need not be complicated to be effective. One simple type that has proven quite effective is illustrated in Fig. 2. In this case road A is of secondary importance to road B-C. By deflecting traffic from road A to a right angle approach, many accidents of the head-on type caused by entering traffic from A, making a wide left turn against traffic is for left turning traffic from B to A, which for this initial treatment should be of light volume. If the traffic from B to A were so small as to be negligible, the design from C, can be eliminated. The short channelizing lane could be further simplified to a single island by the elimination of the short channel.

The above simple channelization is well adapted to future expansion as traffic conditions warrant, without sacrifice of the initial investment. For instance, one of the first steps in expansion might be the construction of a 4-lane divided highway on road B-C. If the islands on road A are properly designed they can be adapted to the new conditions without change by providing proper openings in the division strip (Fig. 3). The short lane within the dividing strip parallel to B-C is a speed change or accelerating lane which should be long enough to allow turning traffic to accelerate to approximately the average speed of traffic along the through road before merging. In this case, left turning traffic from B to A and right turning traffic from A to B is assumed of minor importance not warranting additional expenditures.

If, on the other hand, there is a considerable interchange of traffic between B and A, more adequate provisions should be provided. This is illustrated in Fig. 4, where a speed change or decelerating lane has been added for protection against rear end collision to vehicles slowing to make the left turn from B to A. Also a separate turning lane has been provided to expedite traffic turning right from A to B and to relieve the intersection proper. This lane should have a radius sufficiently long to permit free flow but should not be great enough to allow traffic to enter C-B at greater than the average speed along C-B. The long narrow island along B-C has a dual purpose in that it assures use of the speed change lanes by turning traffic and prevents traffic from B to A from making a left turn from the right lane. Thus the possibility of wrong movements has been almost entirely eliminated while the correct movements are easy and natural.

Although the above is about the ultimate in channel-



TRAFFIC FLOW DIAGRAM

FIG. 1

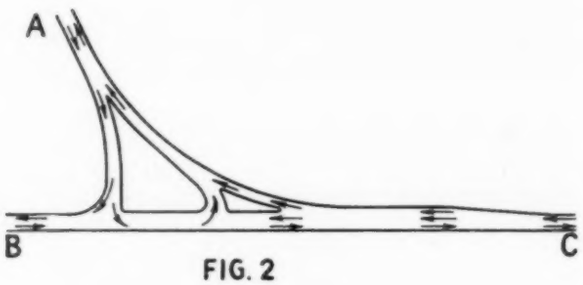


FIG. 2

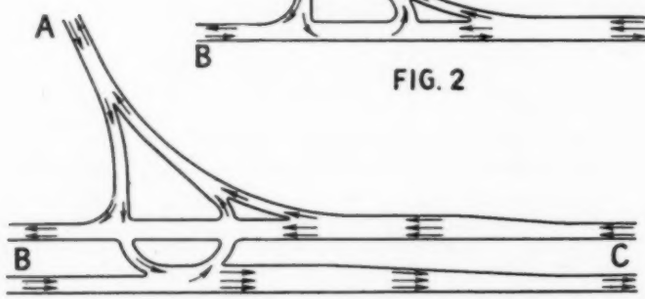


FIG. 3

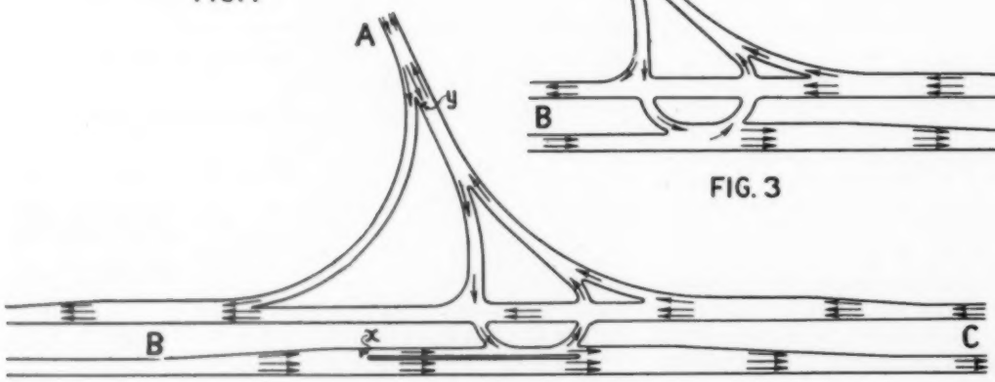


FIG. 4

Illustrating stages in the expansion of the simple "Y" type intersection at grade to keep pace with increasing traffic volume.

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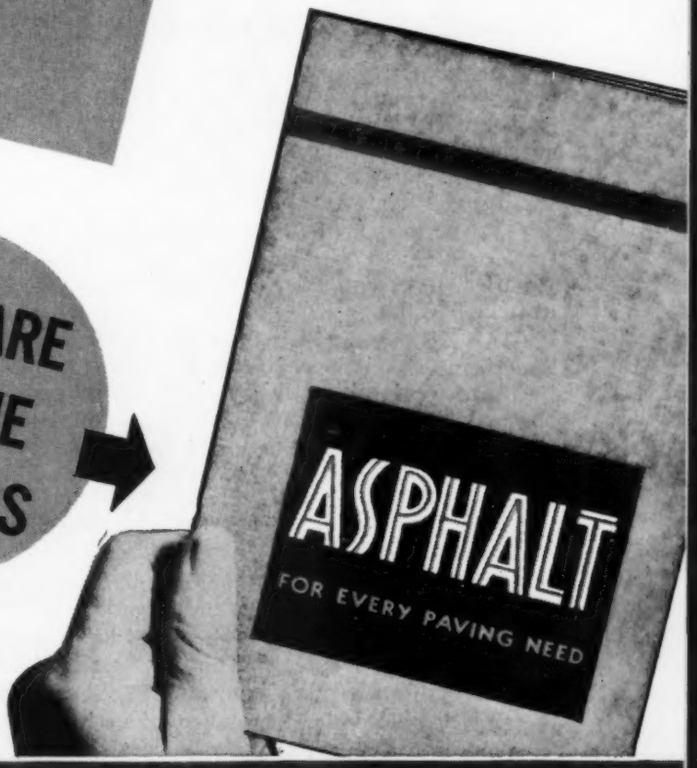

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ization for the particular conditions described, the limit of expansion, without leaving the field of intersections at grade, has not been reached. The engineer still has recourse to traffic signals.

While the use of traffic signals comprises a huge field of study in itself, the full extension of the above type intersection can not be covered without mentioning them here.

This design is particularly adapted to traffic actuated signals which are a comparatively recent development in the intersection field. Simply explained, they consist of treadles so placed in traffic lanes that when passed over or actuated by a vehicle they will set the signal for a predetermined interval so that the vehicle or vehicles may proceed through the intersection while conflicting traffic is stopped. They could be used in conjunction with the channelization shown in Fig. 4 when traffic on route B-C becomes so heavy that traffic from B to A and A to C would be unduly delayed waiting for a chance to cross. Initially, treadles could be placed at x or y or both, if required. The intersection is beginning to look complicated but it is not. Traffic from B to C, C to A and A to B can move through with no delay. Traffic from C to B moves through without delay at all times except when the right of way is lost to traffic from B to A or A to C. At first glance it might appear that the last two movements, although they might be light, could rob most of the "GO" interval from the heavier volume of through traffic from C to B. This is not the case because the traffic actuated signal lends itself to adjustment so that the least delay to the greatest volume of traffic results.

HIGHWAY SUBGRADE SOIL SURVEYS

Conclusions regarding soil surveys for highway subgrade were summarized as follows by Wm. F. Hughes, Assistant National Engineers, Utah State Road Commission, in a paper presented March 5 at the First Annual Highway Engineering Road School, at the University of Utah:

(1) Most states find that at the present time a soil survey conducted under the method outlined by the American Association of State Highway Officials, adequately fills their needs.

(2) Adjustments in the methods, as outlined by the American Association of State Highway Officials, must be made for local conditions, i. e., no set rule can be successfully followed in all cases.

(3) Sufficient borings should be made to completely map all soil horizons. The interval between borings may be as little as 25 feet in areas of great stratification, or as far apart as 1,000 feet over areas of very uniform soil conditions.

(4) The explorations should be carried to a depth of at least 3 feet below subgrade elevation.

(5) Areas of ledge or rock should be explored fully to determine their extent. This can best be done using a power drill of a small diameter.

(6) Samples should be taken of each soil type encountered on the project under survey.

(7) Disturbed samples can best be taken, under normal conditions, using post hole augers of 4-in. or 6-in. diameter.

(8) Undisturbed samples should be taken of all questionable soils. This can best be done using one of the sampling devices now being used by the various states, for instance, the Porter Sampler of California.

(9) All cuts and wells in the vicinity of a project should be thoroughly studied.

(10) Care should be taken to completely map all underground water areas which might influence the subgrade soil behavior. Direction of flow should also be ascertained.

(11) Complete soil profiles should be drawn; first, in the field, and finally in the drafting room.

(12) The final soil profile should contain complete field and laboratory data.

(13) The final report of the soil engineer should include, in addition to the soil profile, recommendation for the proper use of all materials, so that these materials might render more efficient service in the subgrade.

(14) The methods of conducting soil surveys, as outlined by the U. S. Bureau of Chemistry and Soils, certainly should be studied by states where such surveys have been made with the thought of correlating this information for use in highway design.

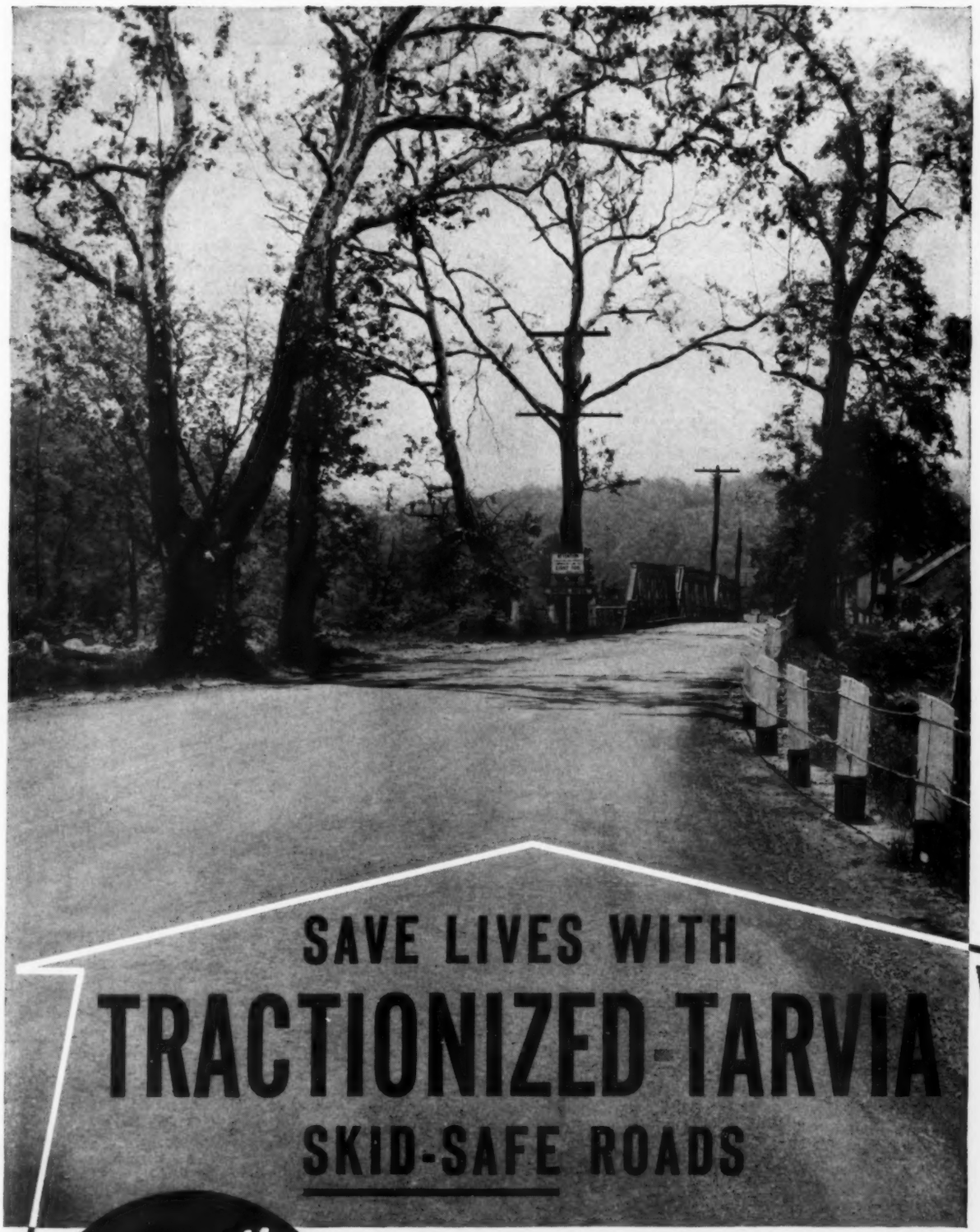
(15) The purpose for making the highway subgrade soil survey is in order that recommendations may be made to the design department concerning the following points:

a. Necessary revisions in the proposed grade to secure a stable and satisfactory subgrade.
b. Any necessary shifting of the horizontal alignment to prevent slides, or secure an improved subgrade material.
c. The design and location of special ditches and subsurface drains.
d. Any necessary revisions of the standard fill slopes or cut slopes.
e. Any necessary subgrade treatment, and the type required.
f. Selection of fill material.
g. Determination of peat removal and rock quantities.
h. Suitability of foundations for heavy fills.
i. To determine the type and quantities of stabilizer material to be used on soil stabilization projects.

HELM RE-ELECTED ASPHALT INSTITUTE HEAD

At their annual meeting, the Board of Directors for the Asphalt Institute re-elected Joseph S. Helm of the Standard Oil Co. of New Jersey, president for the fiscal year beginning April 1, 1940. Vice Presidents elected were: A. M. Maxwell of Standard Oil Co. of Ohio, J. A. Blood of Standard Oil Co. of California, T. M. Martin of Lion Oil Refining Co. W. H. Kershaw of the Texas Co. was elected chairman of the executive committee, with Messrs. J. A. Blood, J. S. Helm, T. M. Martin and David Waxman of the Shell Petroleum Corp., as members, and Herbert Spencer of Standard Oil Co. of New Jersey, treasurer, and F. V. Widger of the Texas Co. re-elected secretary. J. E. Pennybacker was re-elected managing director.

Map Showing Location of Contractors in Pennsylvania Turnpike.—A sectional map showing the route of the Pennsylvania Turnpike between Harrisburg and Pittsburgh with all contracts indicated is now on sale at $1 each at the Contract Bureau Office of the Pennsylvania Turnpike Commission, Harrisburg, Pa. This map affords an excellent means for locating contractors working along the various sections of the route. Eugene Martin of the Bureau should be addressed.



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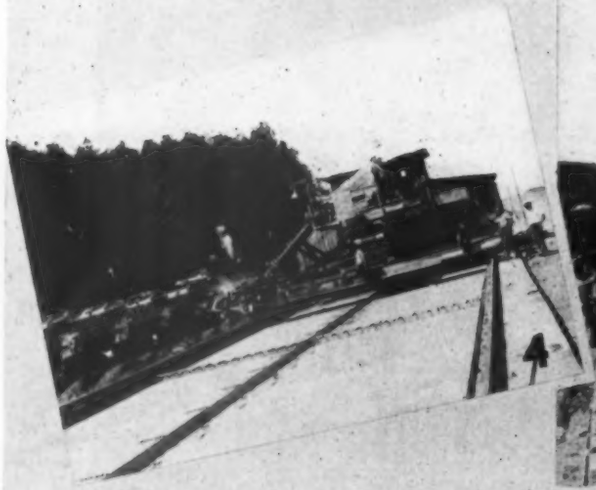

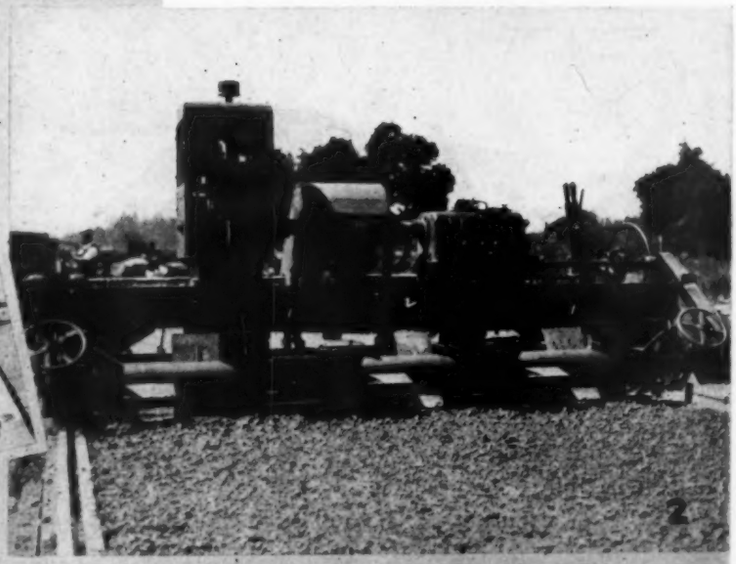

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PIPE INSTALLATION BY DRILLING

How a 10 In. Main Was Placed Under a 7 Track Railroad Embankment

By DANA McKNIGHT
Engineer-Superintendent
Peter J. Crowley Co., Maywood, Ill.

DURING September 1939 the Public Service Company of Northern Illinois decided to install a 10-in. gas main under the Indiana Harbor R. R. tracks in Summit, Ill., west of Archer Ave. This work was to be at a point where the railroad has seven tracks which would call for an installation under the tracks approximately 100 ft. in length.

The railroads are very strict, and rightly so, in matters covering any installation under their tracks. In this case they would insist, as tunneling was necessary, that all trenches under the track be sheeted and that the tracks be supported on timber shoring sufficient to carry all loads over the track. The railroads also insist that no open cutting be made between any set of tracks as a safeguard against any trainmen stepping into the open excavation.

In this case it would be necessary to tunnel approximately the entire 100 ft. under the 7-track span. Starting from the sides of the embankment would require an average tunnel excavation from each end of 50 ft. A tunnel approximately 3 ft. wide and 5 ft. high and completely shored and braced would have to be dug. The dirt excavated would have to be carried back through the tunnel approximately a distance of 25 ft. Upon completion of the excavation and the installation of the pipe the entire opening would have to be backfilled and thoroughly tamped and the sheeting removed as the backfilling progressed.

Drilling Operations for Installing a 10-In. Gas Pipe at Summit, Ill.

This type of installation is a dangerous and costly method, dangerous both for the railroad's safety and the safety of the men performing the work.

The Peter J. Crowley Co., Paving Contractors, of Maywood, Ill., operators of a Permanco horizontal drilling machine contracted to drill under the tracks for this installation.

A hole 4 in. in diameter was first drilled from one side at the proper grade for the total distance of 100 ft. This was followed by drilling from each end using drill capable of reaming the 4 in. hole up to a diameter of 14 in. The drilling in the case of the 14 in. drill was carried on from both ends because the economical workable length of the present machine using the large drills is approximately 60 ft.

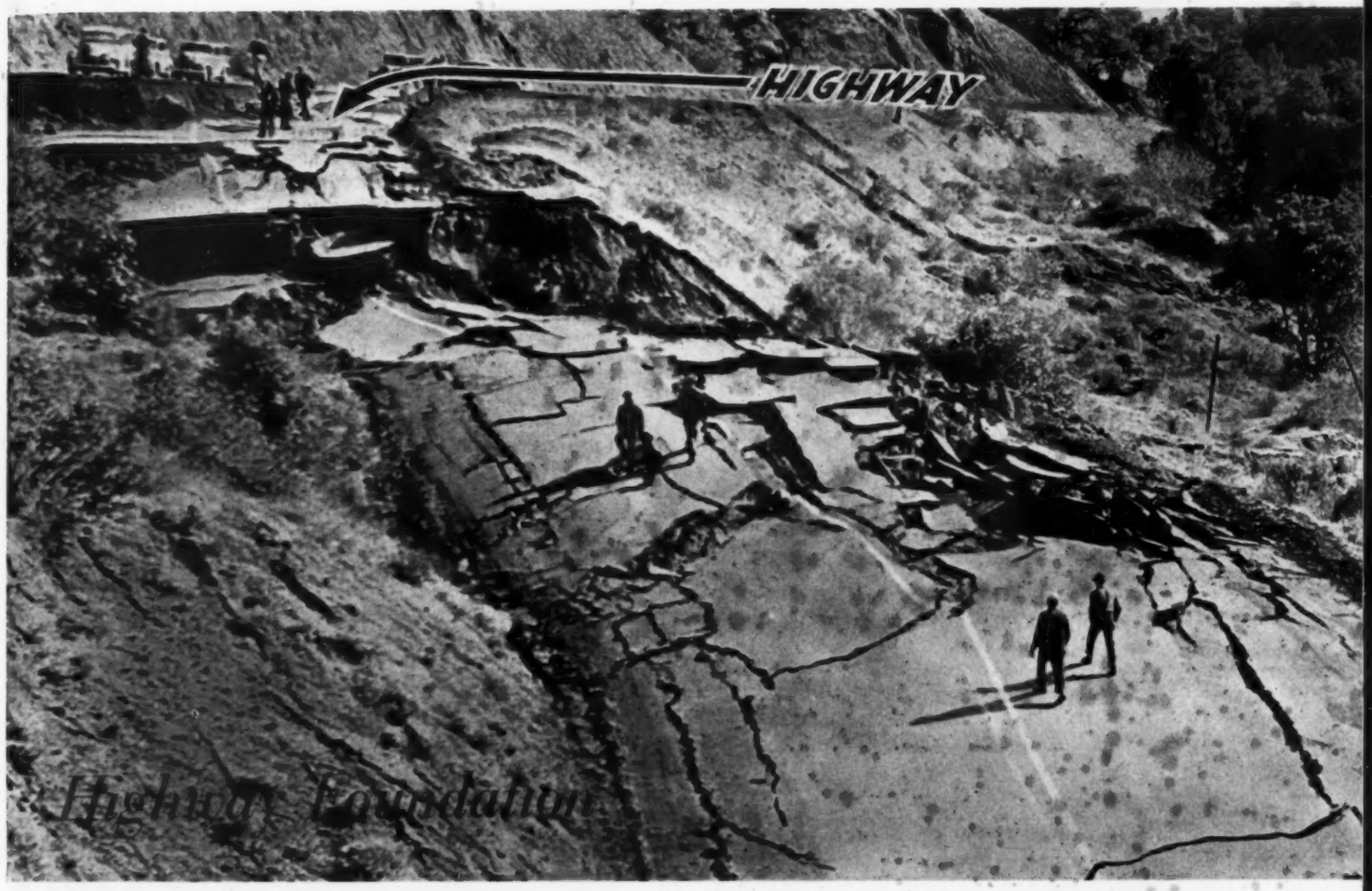
This work was carried on by a crew of 3 men with the machine in 16 working hours at a price of $3.50 per foot. The actual installation of pipe was done by the Public Service Co., with very good success.

After the installation the only backfilling necessary was to fill the pits needed on each end of the digging to set the machine down to the proper grade to accomplish the drilling.

The horizontal drilling machine augers through the earth using sections of drill approximately 3½ ft. in length and constructed with spiralled blades with patented interrupted flights of openings at approximately 8 in. centers on the spirals which return the excavated material to the machine in very small round particles which are easily handled. In no case whether the earth is dry or wet will the material clog the auger flights with this type of interrupted flight.

The Permanco Horizontal Drilling Machine manufactured by the Paris Mfg. Co., of Paris, Ill., is the patent of Mr. Alan J. Parrish who is known for his work as a paving contractor in the pavement construction industry in Illinois.

Fifty Engineering Schools Have Courses in Soil Mechanics—Approximately fifty engineering schools in the United States and Canada now offer courses in soil mechanics or include extensive material on soil mechanics and soil testing in courses in foundation or highway engineering or both.



North of Cloverdale, California, 400 Ft. of U. S. 101 Went Out With a Big Slide, During Spring Rains—Photo Courtesy San Francisco Examiner.

TREATMENTS PREVENT SLIDES AND SLIPOUTS IN CALIFORNIA

Geological, Geophysical, and Soil Sample Studies Assist Investigational Work for Preventative Construction

By O. J. PORTER

Senior Physical Testing Engineer, California Division of Highways

PERIODS of prolonged intense rainfall accelerate incipient slide and slipout conditions on highways as well as other structures. During the heavy rains of February 25 to 29 in Northern California storm damage has been estimated at $1,267,000. Part of this is bridge losses and part of it roadway losses. The major items of the loss are as follows:

U. S. 101—Redwood Highway

1. Failure of north approach span across the Eel River at Scotia.
2. Slipouts at Greenlaw and Shively Bluffs.
3. Slipout two miles north of Cloverdale.
4. Slides at Waldo approach.
5. Slipouts between Garberville and Miranda.

U. S. 101—Bayshore Highway By-Pass

1. Slide at Brisbane.
2. Bulkhead failure at Francisquito Creek.

State Sign Route 12—Russian River

1. Slides and slipouts, Guerneville to Monte Rio.

State Sign Route 20—Tahoe-Ukiah

1. Washout at Cache Creek.
2. Slide along Clear Lake.
3. Other slides and slipouts.

U. S. 99—Pacific Highway

1. Damage to bridge north of Redding.

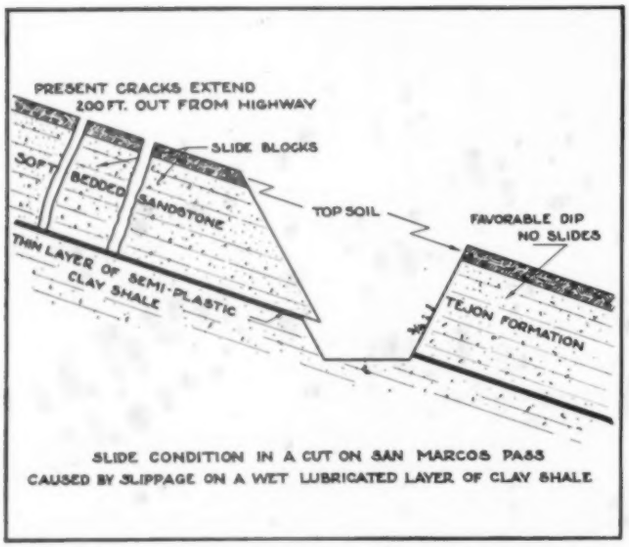


Fig. 1—Diagram of a Cat Slide Illustrating Plane Slippage Due to a Lubricated Layer. Unfavorable Dip of the Rock Strata Could Not Be Avoided.

State Sign Route 24—Feather River Highway

1. Severely damaged by washouts and slides at several points from west of the Butte-Plumas County line to east of Quincy.

The estimated losses are divided as follows:

Bridges destroyed or damaged	$ 192,000
Fills washed or slipped out	489,000
Slides	586,200
Total	$1,267,200

As indicated by the table, the major portion of the loss is due to inadequate foundations under the road at many places. All new construction finished in accordance with the foundation treatment theories explained herein withstood the recent storms; failures occurred only to those places on old construction where no foundation treatment was applied.

Foundation Problems

Where the slides and slipouts have occurred, some realignment or modernization has been done. One of the serious problems in connection with realignment and modernization of highways in California is the unstable foundation conditions often encountered. Sloping cross draws and side hills where construction of heavy embankments and deep cuts may be unavoidable are usually the location of these slipouts and slides. However, considerable of the terrain in the coast range is covered with landslides which have been moving for thousands of years. Unless adequate foundation support is given to heavy embankments to be constructed in these areas, slips and slides will be extremely costly to the state. Engineered drainage, combined with a balancing of stresses, will prevent these losses.

Fig. 2—Picture of Present Condition of the Cut Slide on San to Avoid Sliding Blocks.

In California a distinction is made between slides and slipouts. In slipouts, only the soil out of which the embankment was constructed, including usually that upon which it was placed, is involved; a portion of the roadbed embankment moves laterally and downward. A slide usually occurs at a side hill cut. The hillside above the roadway moves laterally and downward sometimes without causing any movement to the roadbed, but usually movement of the roadway, either cut or fill is involved. In some cases the roadbed moves laterally and downward with the upper surcharge of hillside soil; in other cases the outer edge of the roadbed rises when the upper surcharge of hillside soil moves out and down. These phenomena may involve only shallow depths, but more often deep movements are the case and include the substrata below the original ground line upon which the embankments were placed. In the slide areas, old slides and relatively deep layers of overburden are often encountered. Under such conditions protection against slides or slipouts is quite expensive. On the other hand, the highway must be kept open for traffic, and when a slide or slipout occurs the entire embankment material and involved substrata must be removed down to firm material. Curative measures are applied before the embankment or roadbed is rebuilt. This is many times more expensive than applying protective measures prior to construction of the new or modernized roadway over questionable ground. Recognizing this fact, the California State Highway Department has given the subject intensive study.

Fig. 3—Slipout Caused by Hydrostatic Pressure and Saturation of Fill Material.

Causes of Slides and Slipouts

Investigations indicate that slipouts may result from any of the following four causes but usually more than one is involved; all are related to the drainage and compaction conditions of the ground:

1. Slippage may occur along a thin, well defined, wetted stratum which acts as a lubricated plane. This movement frequently occurs along a weak bedding plane which in some cases may lie between two layers of firmer material. Figure 1 is an illustration of this type. In Fig. 2, the sandstone strata with unfavorable dip are sliding on a thin, lubricated layer of clayey shale.

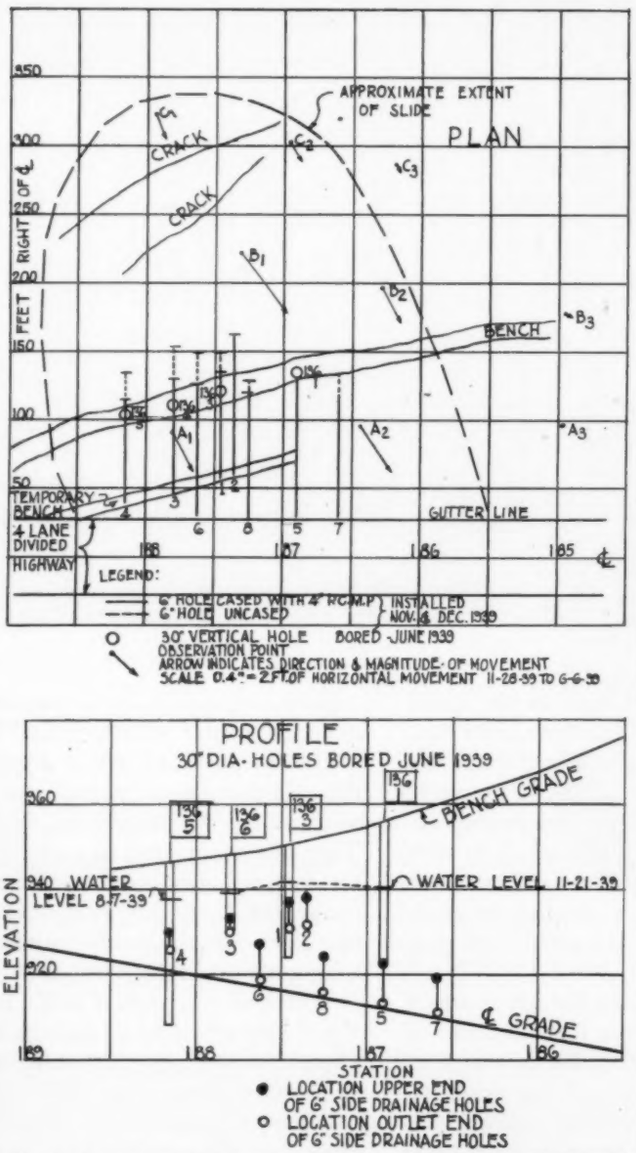


Fig. 4—Layout of Vertical Sand Drains Tapped by Horizontal Drainage Pipe at Stations 185 to 189, Cuesta Grade, California.

Correction of this type may be accomplished by breaking up and draining the sliding plane. A hole bored into the seam could be loaded with explosive; when fired it would shatter pieces of the sandstone and mix the shattered pieces with the lubricated stratum. Drainage would remove the water and sliding would be prevented. On the San Marcos Pass road where this case occurs, corrective measures have not as yet been applied, as it has been possible to make a minor line change, moving the roadbed away from the slide. Huge blocks of sandstone have broken loose as far as 200 ft. back from the road.

2. Slipouts may occur when the embankment or the foundation soil becomes saturated by the impoundment of hillside seepage behind an impervious fill. Heavy embankment loads usually consolidate and disturb compressible foundation soils to the extent that former natural seepage through underground pores is stopped, creating a sort of dam out of the embankment and compressed substrata.

This may result in a rise of the ground water level above the fill with the hydrostatic pressure contributing a considerable portion of the total horizontal forces causing failure. Water of saturation pushes with hydro-

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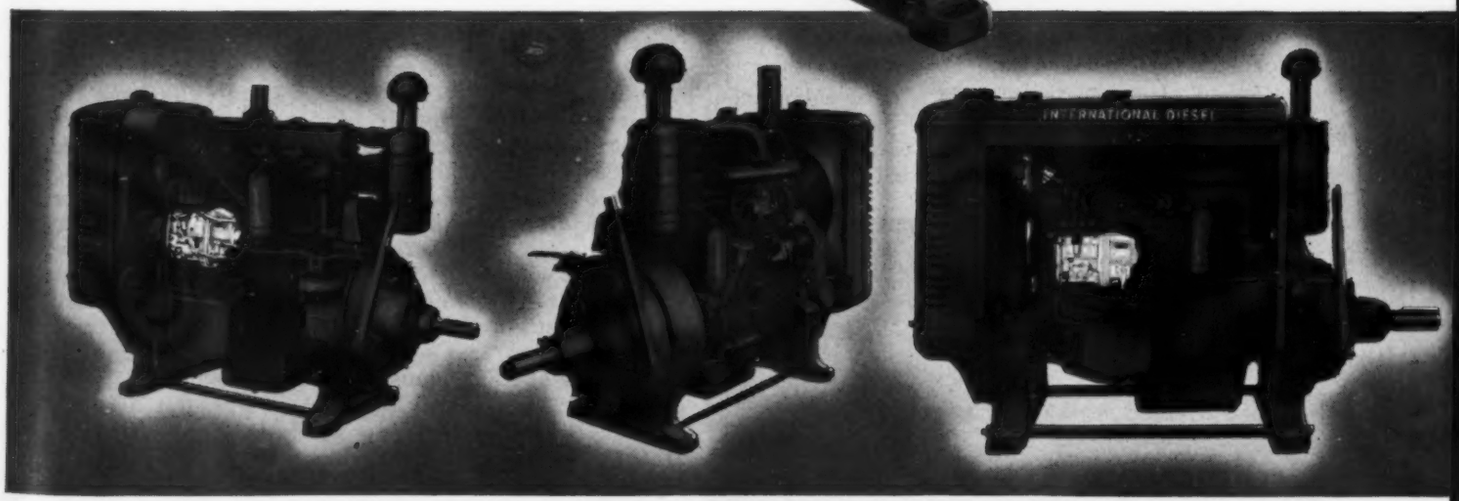

Above: **Here is International Harvester's small Diesel, the UD-6 (shown equipped for indoor use). This 4-cylinder engine packs a lot of power for its size and has the stamina to stand up under the toughest kind of operating conditions.**

Above: **The UD-9 Power Unit (shown here without engine hood) meets the demand of users for a medium-small International Diesel. Its low-cost power can be applied in many different ways to effect important savings and step up efficiency.**

Above: **The International UD-14, medium-large Diesel Power Unit, is a popular size for powering a great variety of equipment and operating as an individual power plant. Put this engine to work and you'll find it a dividend payer.**

INTERNATIONAL Industrial Power

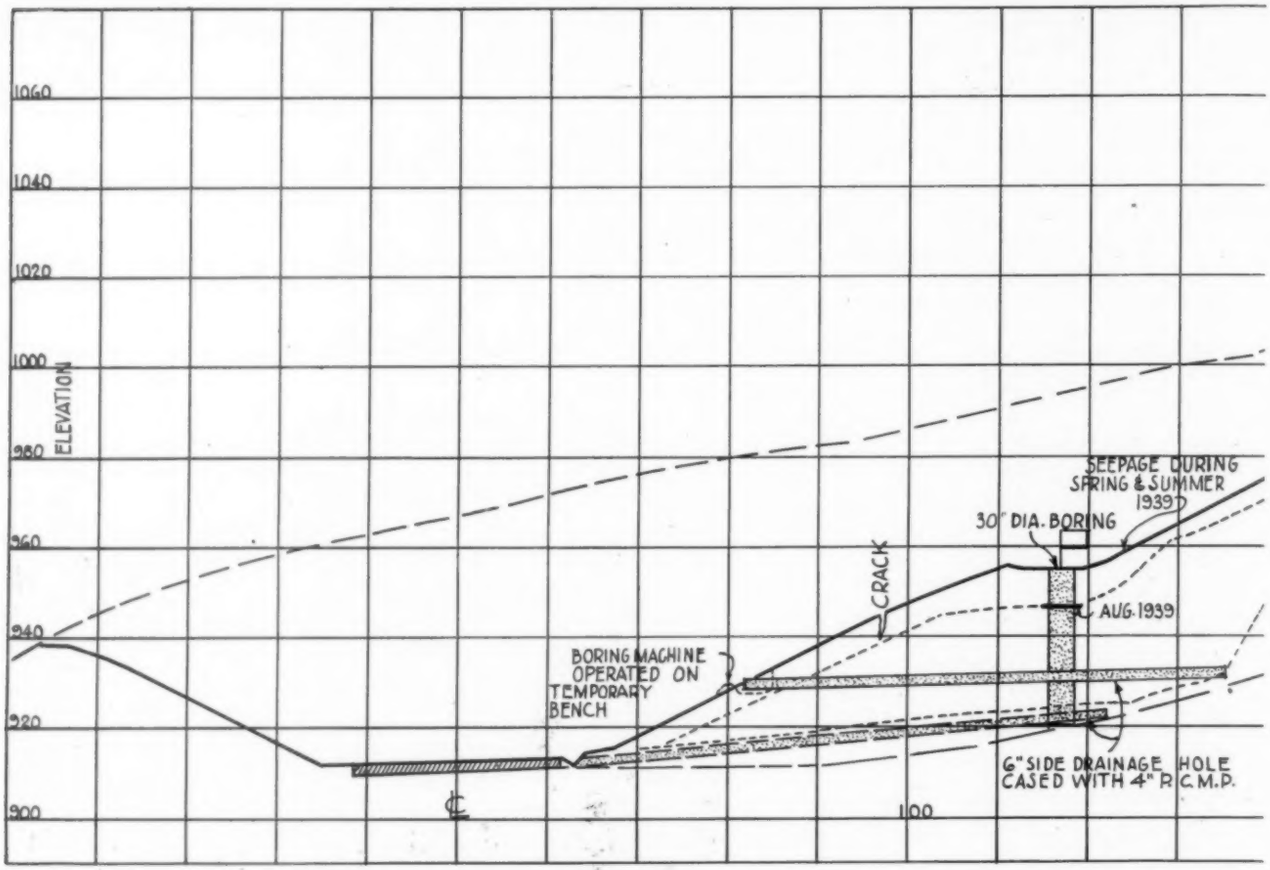

Fig. 5—Typical Section of Cut in Fig. 4 Showing Slide Conditions, Vertical Sand Wells and Horizontal Slide Drainage Holes. installed November, 1939.

static head outward against the soil particles, as well as lubricating them. Gravitational force on the embankment becomes stronger than the cohesion and internal friction of the soil and a slipout results. In slipouts, the line of break more frequently occurs near the center of the roadbed.

Protective measures against this type of failure consist, usually, of providing adequate drainage by cut off trenches above the fill. Placing very porous material on the bottom of the embankment, provided the foundation is firm, or where the depth of overburden is relatively thin, will usually prove effective also.

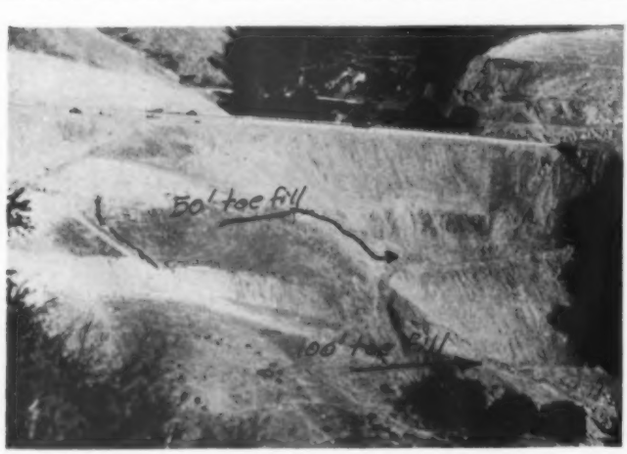

Fig. 6—Cuesta Grade Project Near San Luis Obispo, 160-ft. Fill. Average Overall Slope Flattened by Construction of Two Toe Support Fills, One 50 ft. Wide and the Other 100 ft. Wide. Internal Foundation and Embankment Stresses Are Thus Relieved. Height of Fill Realized by Comparison With Automobile on Roadway.

A previous slipout similar to the one shown in Fig. 3 but of much greater movement resulted when a moderately high fill, 20 to 30 ft. in depth, over about 25 ft. of old slide material, went out. Seepage from the upper hillside during a wet winter was entrapped above the fill, creating a hydrostatic head, saturating and lubricating the embankment soil and foundation slide material. Correction in this case was effected by trenching to the bottom of the cross draw, below and under the slide. A drain was then constructed on top of the firm substrata out of a corrugated perforated metal pipe backfilled with rock on the bottom and sides of the trench. The hole and embankment was then reconstructed with well-consolidated material. In this case the cross draw was not very wide. Surface drainage structures, of course, must also be provided.

Figure 3 is an illustration of this type of failure. A heavy fill crossed a deep cross draw, compressing the substrata and virtually damming up the underground seepage flow. The rains on February 25 to 29 provided enough excess moisture to cause failure.

Slides may occur from hydrostatic head when the toe of an incipient slide condition is removed or a cut is made into it. An example of preventive treatment of this type of slide is shown by Figs. 4 and 5.

The plan, as shown by the cross-section of Fig. 5, called for a 56-ft. cut below the original ground surface of an old slide. This would have completely disturbed the equilibrium established by nature at this point. On the bench shown in Figs. 4 and 5 test holes were driven

[1] 1938 Proceedings of the Highway Research Board, Part II, Page 430.

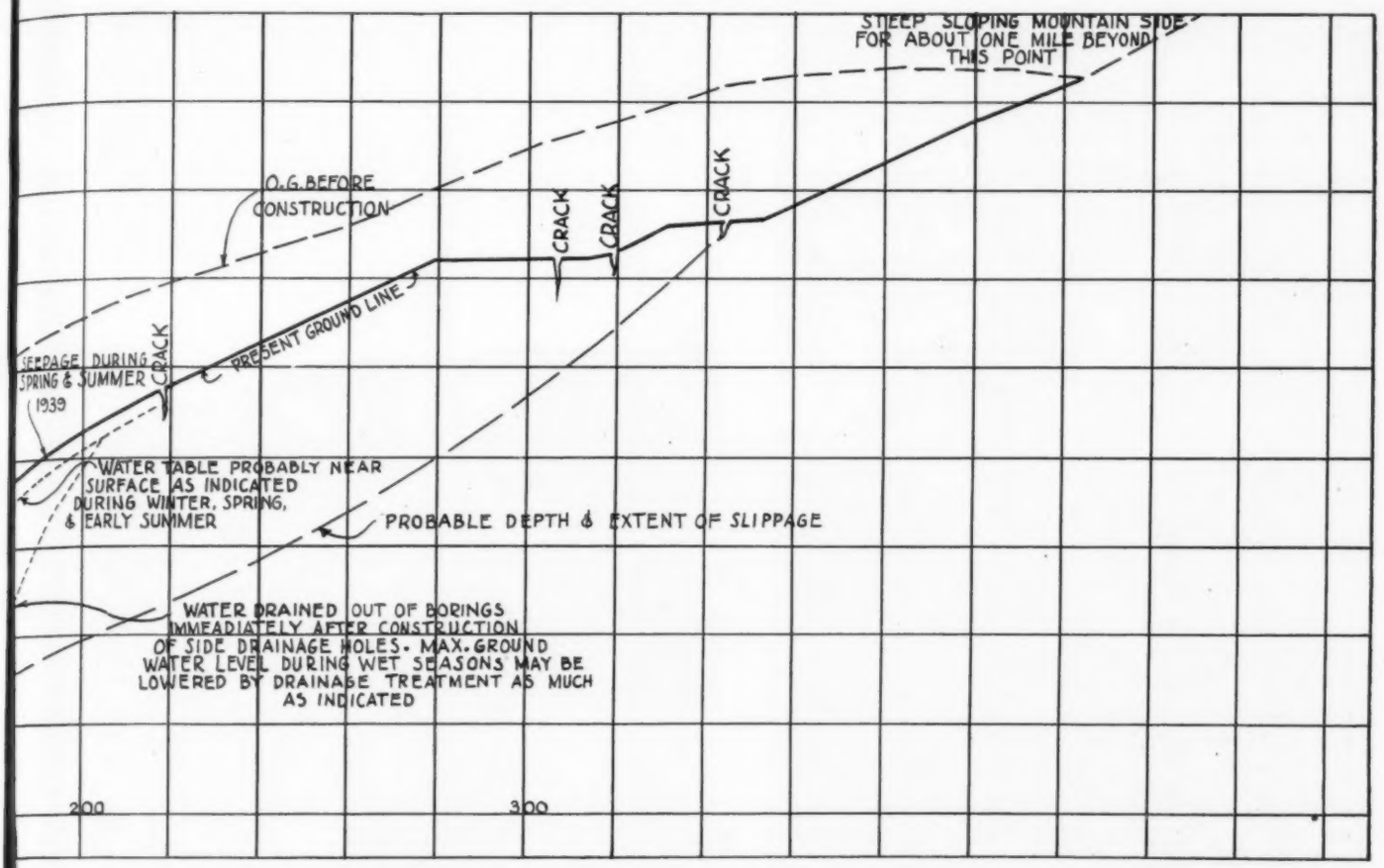
STEEP SLOPING MOUNTAIN SIDE FOR ABOUT ONE MILE BEYOND THIS POINT
O.G. BEFORE CONSTRUCTION
CRACK
CRACK
CRACK
PRESENT GROUND LINE
SEEPAGE DURING SPRING & SUMMER 1939
CRACK
WATER TABLE PROBABLY NEAR SURFACE AS INDICATED DURING WINTER, SPRING, & EARLY SUMMER
PROBABLE DEPTH & EXTENT OF SLIPPAGE
WATER DRAINED OUT OF BORINGS IMMEADIATELY AFTER CONSTRUCTION OF SIDE DRAINAGE HOLES. MAX. GROUND WATER LEVEL DURING WET SEASONS MAY BE LOWERED BY DRAINAGE TREATMENT AS MUCH AS INDICATED
200
300

Fig. 5—Typical Section of Cut in Fig. 4 Showing Slide Conditions, Vertical Sand Wells and Horizontal Slide Drainage Holes. Installed November, 1939.

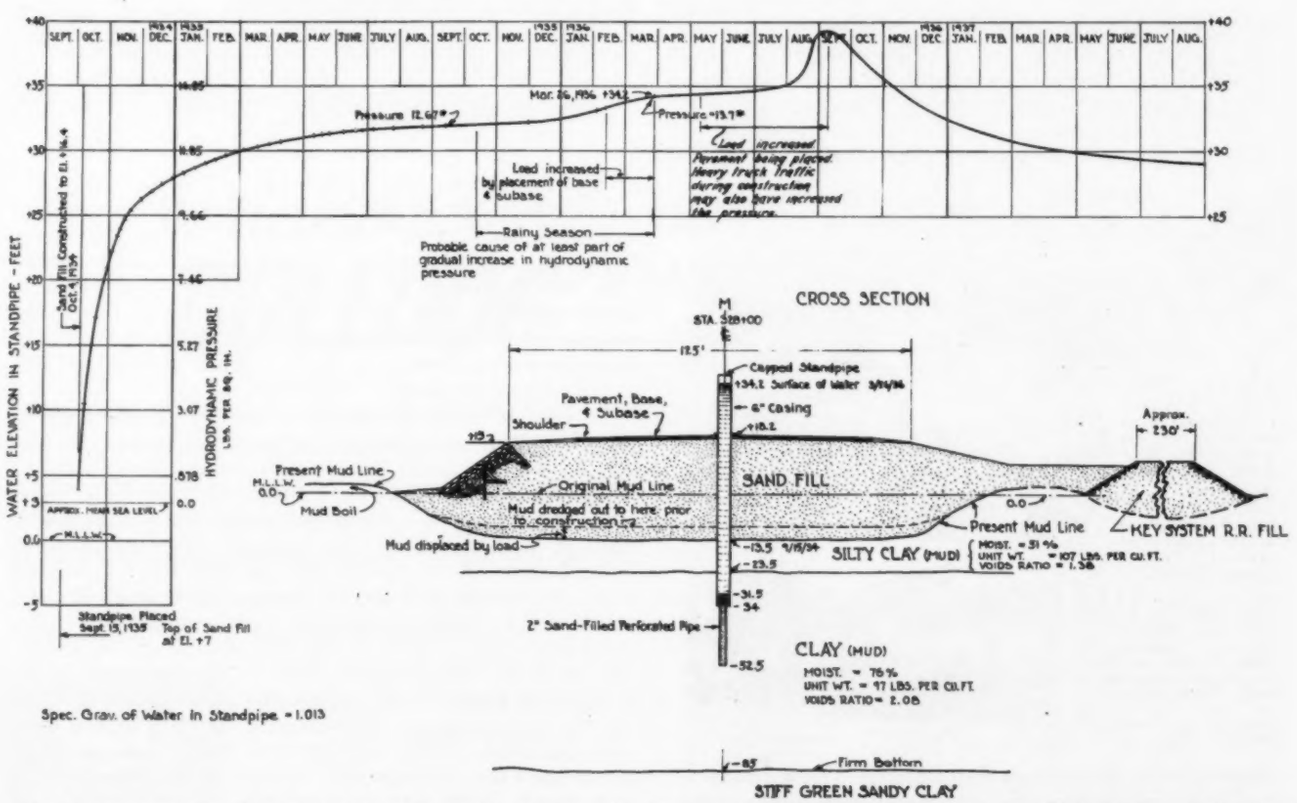

Fig. 7—Diagram Showing Pore (Hydrodynamic) Pressure Resulting from Fill Load on Saturated Compressible Foundation Soil and Rise of Water in Standpipe to Prove the Pressure. Fill Made for East Approach to San Francisco-Oakland Bay Bridge.....

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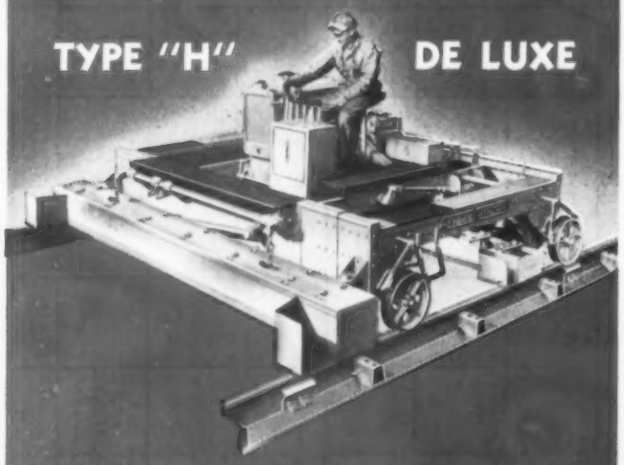
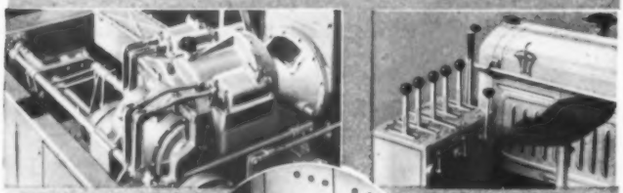


NEW SPEED AND TRACTION to match 34E Dual Drum Pavers and Jaeger Screw Spreaders on dry mixes. 4-Speed Automotive Transmission has working speeds to 18 F.P.M., positive drive to 4 equally loaded wheels.

NEW SMOOTHNESS OF FINISH with rigid, fully enclosed, spring cushioned 12" screeds, independently controlled.

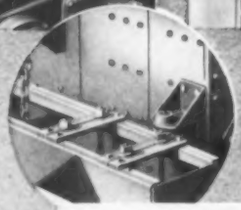
COMPLETE CONTROL—all levers banked in front of operator, including separate screed and traction speeds, fast hydraulic power lift for each screed.

GREATER TELESCOPIC WIDTH CHANGES — Central unit and side trucks completely self-contained. Quickly extend Telescopic Frame and insert Screed Sections for built-in width changes; merely insert wider cross members and screeds for widths to 30 ft. Merely move wheels for 1/4" to 3" adjustments.



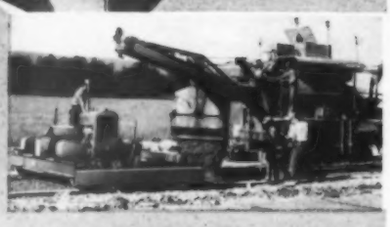
One Heavy Duty Central Transmission, direct connected to Engine, performs all functions.

Double Row Crown Adjustment standard. One Lever operates improved Quick Crown Change Screed.



Throttle, Engine Clutch, Steering, Forward-Reverse, 3 Screed Speeds, 4 Traction Speeds and Screed Lifts—all banked for operator.

JAEGER SCREW SPREADERS—a necessity with Dual Drum Pavers. Re-Mix; spread and strike-off fast as Paver can produce, densify the slab, speed production, cut costs. Over twenty now in use on Pennsylvania Turnpike.



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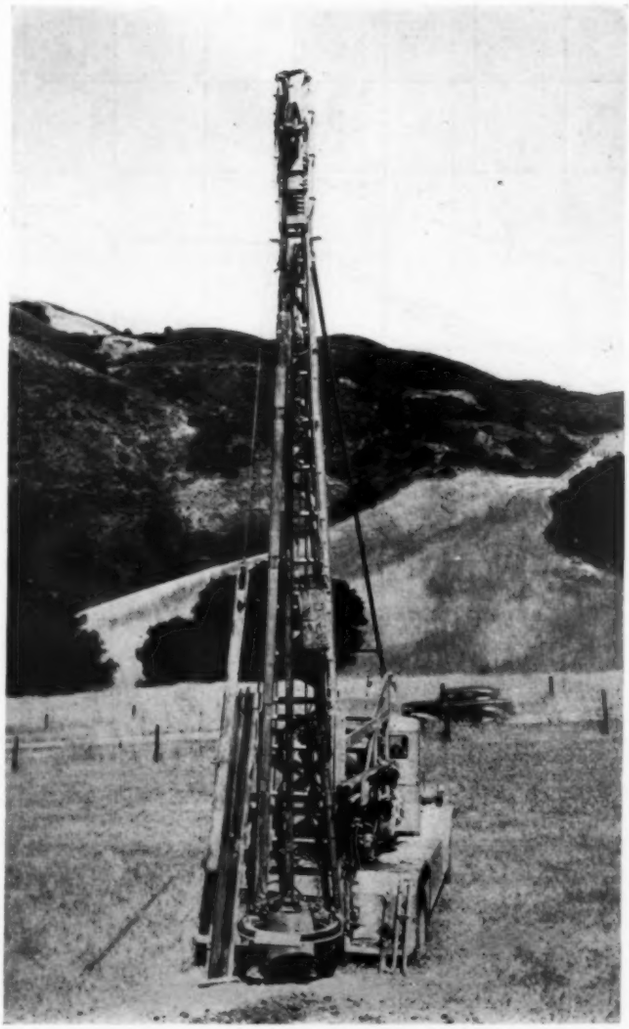
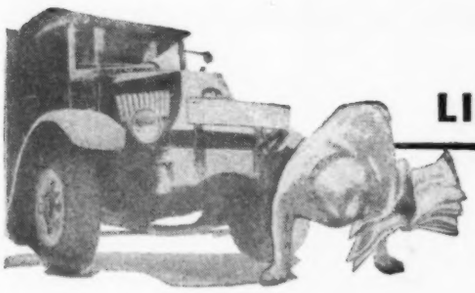


Fig. 9—Perfected Combination Power Drill for Making Foundation Investigations Developed by O. J. Porter, Senior Physical Testing Engineer, California Division of Highways.

by a powered foundation exploration drill to obtain undisturbed test cores. The Porter soil sampler previously described by Stanton[1] was employed to get the cores and determine the probable depth to the slippage plane. Figs. 4 and 5 refer to stations 185 to 189 of the Cuesta Grade project. Four holes were put down at this point and a record of ground water level obtained. Hydrostatic pressure with reference to the toe of the slide where the highway cut was made is apparent.

To relieve this pressure and to remove ground water in order to increase the value of internal friction, a system of vertical sand drains individually connected to horizontal outlet drains were found to be the most economical procedure. As indicated by Fig. 5, incipient slippage was evident by the cracks in the new ground surface over 300 ft. uphill from the roadway. Analyses of various probable lines of slippage were made by the cut and try Swedish method. Soil sample tests indicated safe values of "C" and "Φ" to use in the calculations. After the probable plane of slippage was determined, the depth of the sand wells could be established for insurance against seepage past the line where they were installed. These vertical sand-filled drainage wells intercepted the underground seepage that caused hydrostatic head. What water seeped into them was conducted to the road ditch by horizontal holes drilled from the cut backslope to intersect the vertical sand wells. In these



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73,000 MILES with tremendous overload . . . on tough mining haul

Says Elmer R. Gotthardt of East Palestine, O., whose Mack Model EF is shown above:

"I have driven this truck over 73,000 miles . . . with a net payload of approximately 14,500 pounds . . . hauling coal from strip mines in Eastern Ohio. Loading conditions at the mines are very difficult and demand everything a truck has.

"During this period I have had no trouble with rear axle, clutch or transmission and work on the engine has been limited to valve grinding and ignition tune-up."

THE MOST COMPLETE LINE OF TRUCKS IN THE WORLD—1 TO 30 TONS AND ALL "HEAVY DUTY"!

Fig. 8—Alignment of Cuesta Grade Project Showing Embank ments During Construction. Fill "A" is 95 ft. High, Fill "B" at Station 250 is 155 ft. High, and Fill "C" is 160 ft. High. Figures 10, 11, and 12 Refer to Fill "B."

6-in. drilled holes, 4-in. perforated corrugated metal pipe was pushed. In the plan view of Fig. 4 these metal pipes are shown as solid lines intersecting the sand wells. The dotted lines shown are continuations of the drilled horizontal holes, but the corrugated metal pipe came to refusal before getting to the end of the holes.

Drying up the toe of this slide increased the internal friciton and relieved hydrostatic presure. Removing the top of the slide where the cracks are shown in Fig. 5 lightened the load and thus reduced the total driving force tending to cause slippage to a value below the resistance provided by "C" and "Φ."

3. Slipouts will occur when there is insufficient shearing resistance in the fill to withstand the horizontal stresses produced by its own weight. When the slopes are too steep for the type of material and the height of the fill, or when the state of compaction of the fill material is too low, slipout will occur. Correct embankment slope design and proper fill compaction are both essential for preventing this type of slipout.

California has been consolidating embankments with optimum water content since 1929 to a relative compaction of 90 per cent or more. Fill slopes are usually built on 1½ to 1 slopes. Where flatter slopes overall are needed, they are obtained, in high fills, by building toe support fills or embankment struts. Flatter slopes are used where it is economical to load the toe of an incipient slide to increase the average frictional resistance and also to provide a counterbalancing load against the driving forces of a possible slide. In the case shown in Fig. 6, however, the two toe fills were constructed in order to obtain a much flatter overall slope, thus greatly reducing the shearing

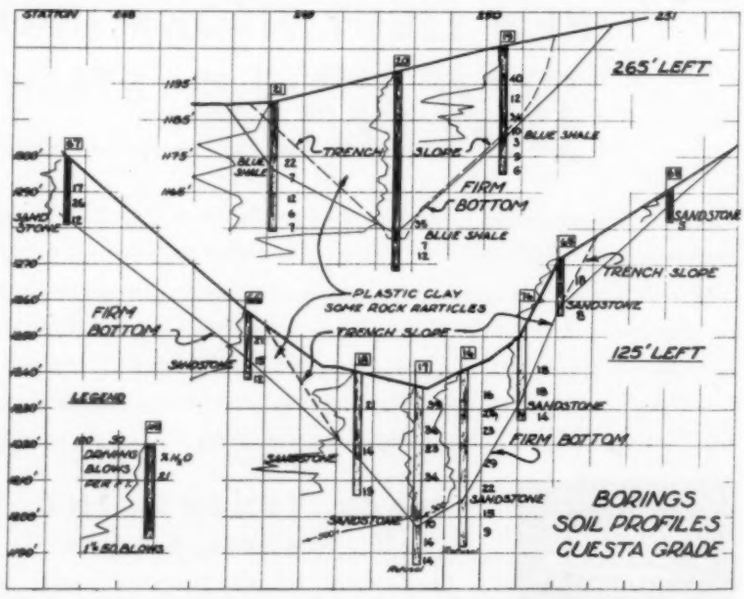

Fig. 10—Foundation on Investigation of Fill "B," Fig. 8. Dotted Lines Show Proposed Drainage Trench Section.

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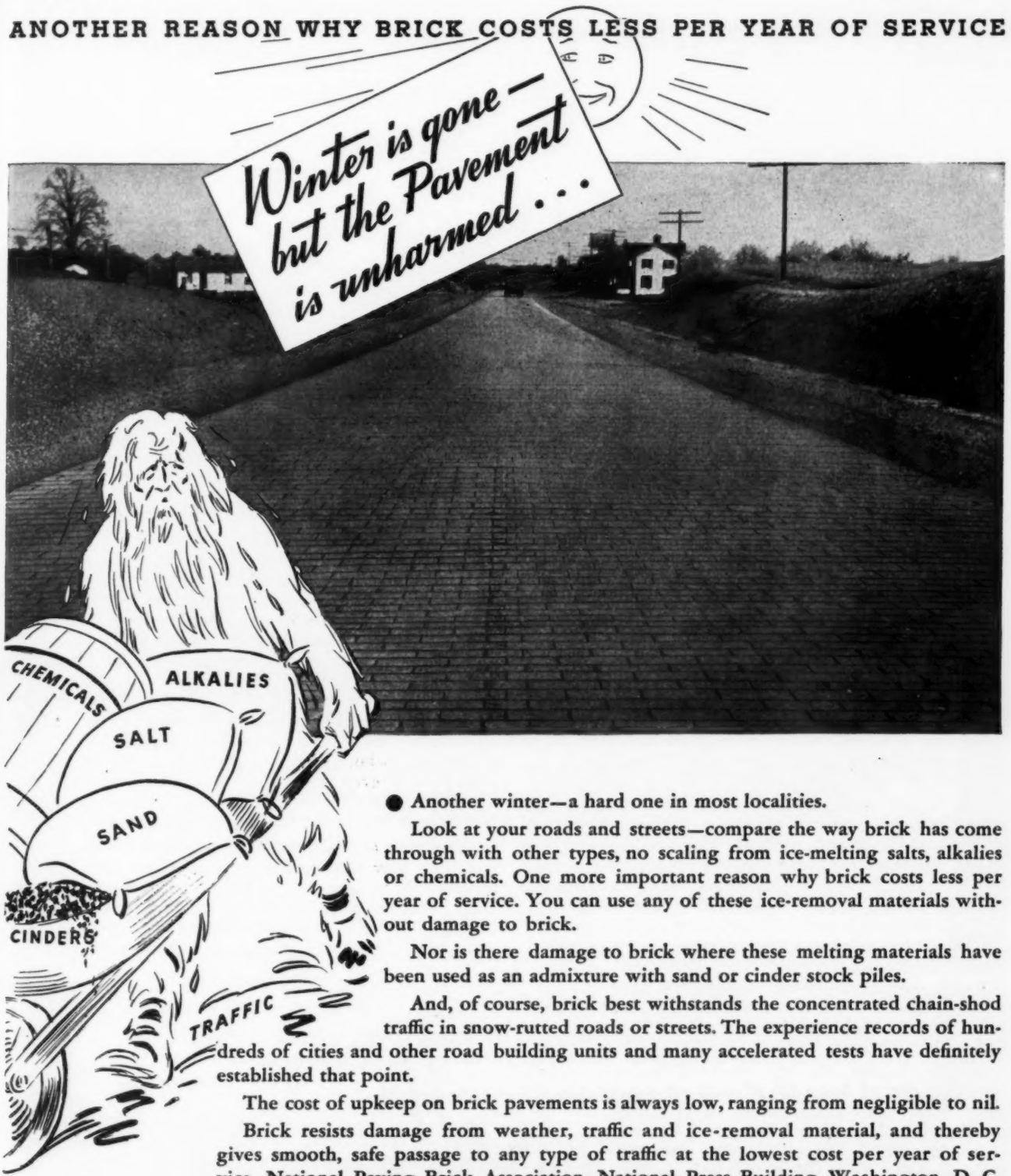

● Another winter—a hard one in most localities.

Look at your roads and streets—compare the way brick has come through with other types, no scaling from ice-melting salts, alkalies or chemicals. One more important reason why brick costs less per year of service. You can use any of these ice-removal materials without damage to brick.

Nor is there damage to brick where these melting materials have been used as an admixture with sand or cinder stock piles.

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The cost of upkeep on brick pavements is always low, ranging from negligible to nil.

Brick resists damage from weather, traffic and ice-removal material, and thereby gives smooth, safe passage to any type of traffic at the lowest cost per year of service. National Paving Brick Association, National Press Building, Washington, D. C.

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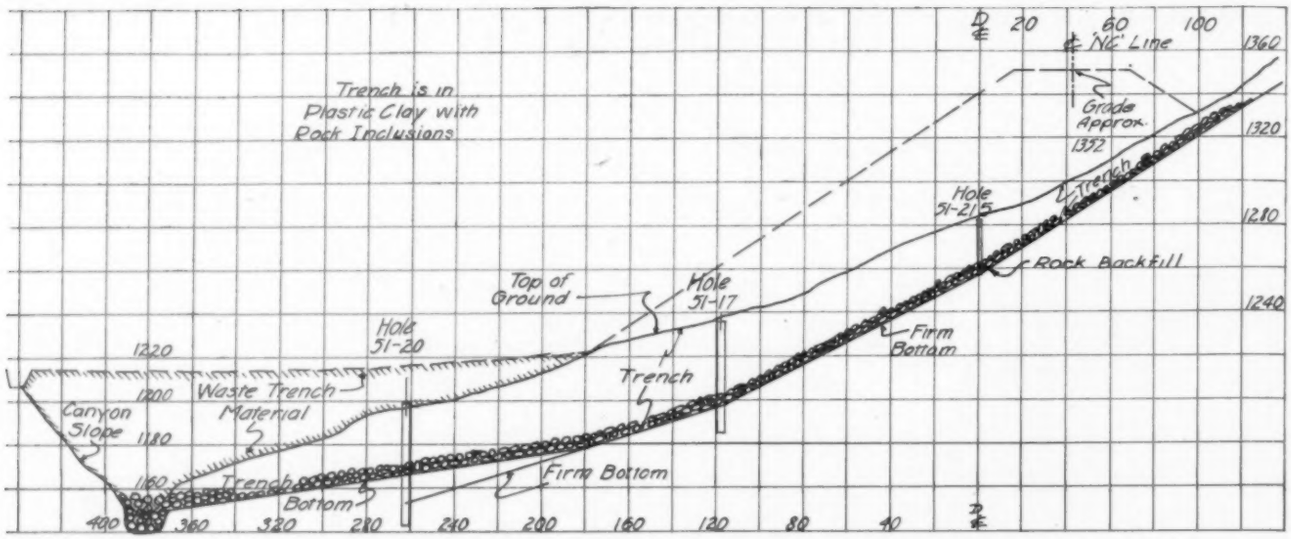

Fig. 11—Profile of Transverse Trench of Fill "B," Fig. 8. Embankment Profile Shown. Trench Excavation Involved 43,000 Cu. Yds. of Material.

stresses in both the foundation and embankment.

4. Failure of an embankment, a slipout, may be due to lateral movement of a saturated or semi-plastic foundation soil when the fill load produces a horizontal component in the semi-plastic foundation soil greater than the shearing strength of that soil. This type of slipout may occur during the construction if no protective measures are taken, even though the work is done during the dry season of the year. It may also be delayed, only a slight amount of settlement taking place during or following construction, with complete failure appearing in a wet season. During the wet spell all of the supporting substrata below the fill reaches a low shearing strength from saturation and out goes the fill.

The water pressure confined in the saturated substrata in some cases equals the total vertical pressure transmitted by the embankment. The standpipe test, Fig. 7, and the other field observations previously described by the writer,[2] indicate that heavy loads on saturated clay are carried, for the most part, by the water in the voids of the foundation soil mass. The resulting pressure is termed "hydrodynamic" pressure and is the pore pressure in the loaded saturated clay. The standpipe test which proves the existence of pore pressure under a fill was made on the east roadway approach to the San Francisco-Oakland Bay bridge.

This phenomenon was first observed during investigations of large fill slipouts on saturated clay soils. Water squeezed up along the shearing plane after failure, and, in some cases, caused an appreciable flow over the embankment. Test holes punched through these embankments to investigate substrata conditions intercepted a pressure which raised the water in the test holes to the top of the ambankment even though the ground water level in the adjacent terrain remained many feet below.

The load, carried by the pore water of the saturated foundation overburden, gradually squeezes excess water out and the foundation soil is consolidated to equilibrium for the total vertical pressure resulting from the weight below.

The load, carried by the pore water of the saturated foundation overburden, gradually squeezes excess water out and the foundation soil is consolidated to equilibrium for the total vertical pressure resulting from the weight of the overburden and the embankment load. Since this pore (hydrodynamic) pressure acts equally in all directions, the assumption is made that this pressure is the prime factor causing this fourth type of failure. Slipouts attributed only to this cause occur rarely; usually the second type is associated with it. Failures of embankments built across flat, marshy ground, or across tidal flats, or even on an underwater foundation of soft, saturated material, may be due to this cause alone; but more often the second type is associated with it.

Correction of a slipout or slide caused by this fourth condition may require the removal of all unstable material or the construction of huge french drains at sufficient intervals to readily relieve the pore pressure by releasing the excess water squeezed out by the embankment load. For larger slipouts, adequate trenches prop-

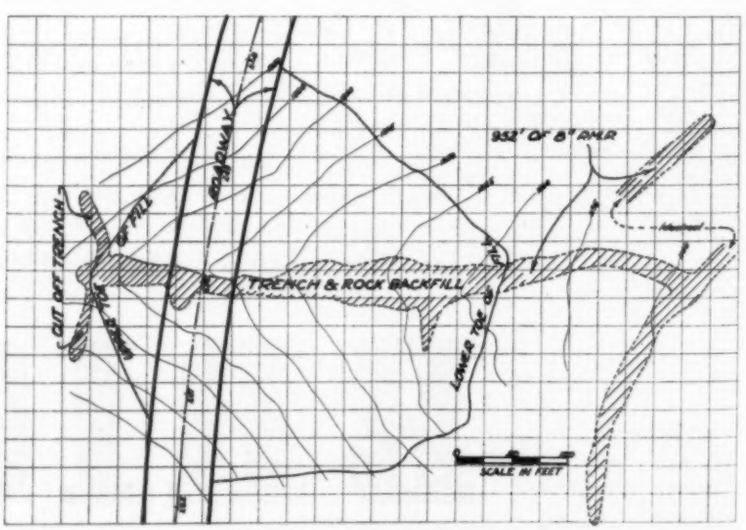

Fig. 12—Trench Layout Employed on Fill "B," Fig. 8. Roadway Shown as Well as Upper and Lower Toe Line's of Fill. Embankment Strut Not Shown.

[2] Studies on Fill Construction over Mud Flats," by O. J. Porter, 1938 Proceedings of the Highway Research Board, Part II, Page 129.

Get Down to the Bottom in Ditching Costs!

For larger trenches, the Buckeye No. 120 digs up to 7'5" per minute, trench widths 18" to 30", and up to 11½' deep, depending on soil conditions. Trenches within 4" of either crawler, close-in to buildings, foundations and manholes, undercuts, walks, drives, pipe and cable lines. Reduces time and labor costs, sidecasts spoil right or left in even windrows.

The Buckeye 410 Ditcher makes up to 38 ft. per minute of 18" to 24" trench to 6 ft. depth, (depending on soil conditions). Only 7'10" wide, it turns in its own radius. Long boom and low ground pressure makes it ideal for undercutting walks, driveways, pipe and cable lines—saving lawns, sidewalks. Easily maneuvered between buildings, foundations. Sidecasts spoil right or left.

Figure it any way you want—by the foot, yard, mile or job—Buckeye Ditchers get right down to the bottom in ditching costs. Cutting trenching costs is an easy matter with a Buckeye 120 or 410 for these high speed trenchers with their inbuilt ruggedness and operating flexibility make more trench, day in and day out, in any soil short of solid rock.

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Makers of Trenching Machines, Convertible Shovels, Finegraders, Surface Graders, Spreaders and Tractor Equipment

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See Page 15.

GRAVEL SPREADERS

FINEGRADERS

SURFACE GRADERS

ROAD WIDENERS

CONVERTIBLE SHOVELS

TRACTOR EQUIPMENT

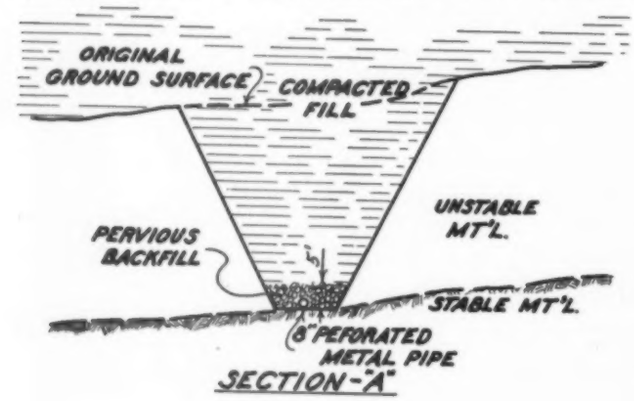
Fig. 13—Mud Flowing From Trench Work on Fill "B", Fig. 8.

erly placed and backfilled with pervious material (crushed rock or gravel) usually prove economical for correcting this type of foundation failure when the thickness of the unstable overburden foundation material does not exceed 30 to 40 ft.

Preventive measures taken prior to construction or modernization are, naturally, considerably cheaper than corrective measures applied after construction and failure. An example of preventive protection against failure by this fourth type, combined with type 2, is given in the following text matter.

Foundation Investigations

Foundation investigations and preventive protection for a whole project can usually be made for the cost of correcting one average failure where no protection against failure was employed. This is true, more particularly, on the higher standard highway designs. Geological and geophysical surveys, borings, and laboratory soil tests furnish the basic data upon which decisions



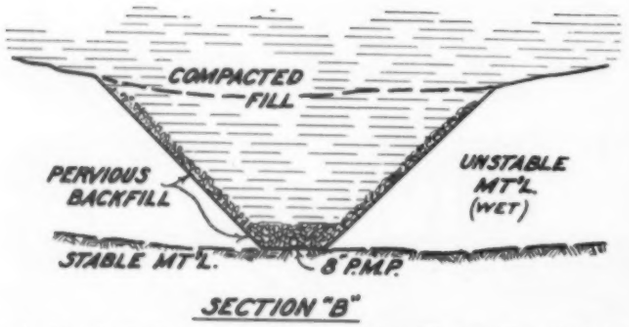


Fig. 14—Typical Drainage Trenches. Note That in Wet, Unstable Material the Trench Walls are Lined With Pervious Material.

are made prior to final design and construction on the foundation treatment required. For illustration, an embankment location study at station 250 on the Cuesta Grade project in San Luis Obispo County, California, is presented.

Proposed construction along the eastern slope of Cuesta Canyon (Fig. 8 shows the alignment, A-B-C, of the new road) encountered heavy fills and deep cuts over and through badly faulted and folded clay shale for a distance of about two and one-half miles. Geological and geophysical investigations disclosed these facts which were not so apparent upon the surface. Observations indicated that the shale weathered rapidly forming an unstable, saturated, clay overburden above the top of the bedded substrata. Electrical resistivity soundings indicated that the fill foundations in most of the cross-draws and side canyons consisted of wet overburden and old slide material ranging between 10 and 40 ft. in depth. In one case it extended down to 75 ft. below the ground surface.

Geophysical studies were checked by extensive large power borings and hand borings in the questionable areas. Undisturbed samples of the unstable material were obtained for laboratory analyses. Borings were continued to firm strata in order that accurate profiles and contours of it could be obtained.

Information thus obtained conclusively indicated that many failures would result from a combination of causes 2 and 4 unless the foundations were properly drained prior to embankment construction. Fig. 9 shows an improved power boring machine devised by the writer [3] and constructed in the shops of the California Division of Highways. Driving blows on the test drill are shown on Fig. 10 as a curve along the left hand side of bored test holes. They show the number of blows per foot of penetration and indicate the relative

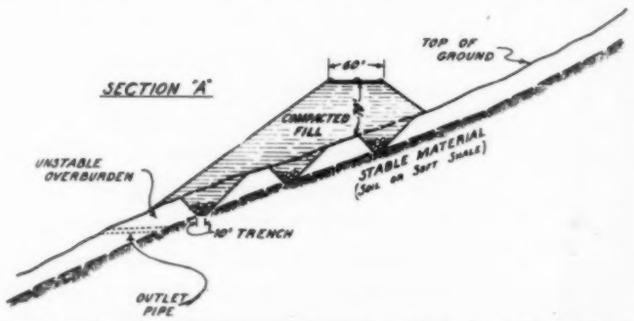


Fig. 15—Showing Drainage Treatment Laterals When More Extensive System is Required Than Was Used on Fill "B", Fig. 8.

density of the subsoil. Water content of undisturbed samples taken at various depths is shown on the right hand side of the bored holes. The dashed line shows the trench section that developed during construction for drainage of the saturated subsoil.

Fig. 11 shows the embankment cross-section and the trench section profile for drainage. All material excavated from the trenches was wasted as shown at the left of the profile. This wasted material serves as a toe load on a possible slip plane and as an embankment strut.

Fig. 12 shows the trench layout employed on this fill subsoil drainage. The long outlet drain and lateral shown below the fill toe are required to drain the embankment strut. This strut was carried across to the slope of the opposite canyon wall. The depth of the fluid subsoil at this site was about 40 ft. Embankment "B" of Fig. 8 is the one explained here. Fig. 13 shows the consistency of the saturated foundation subsoil.

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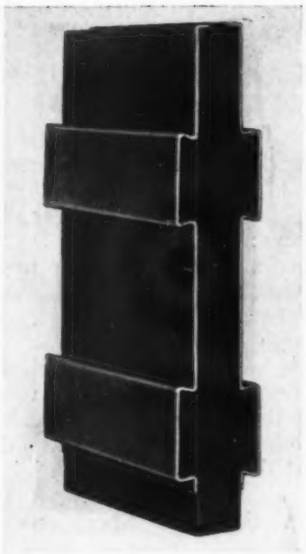

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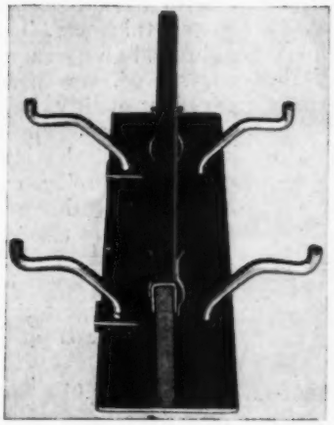

Load Transfer Plates can be made in continuous sections or individual plate sections.

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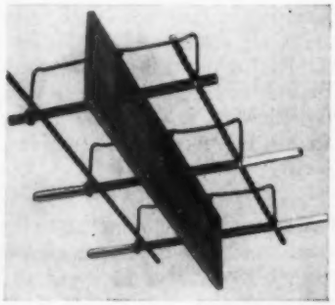

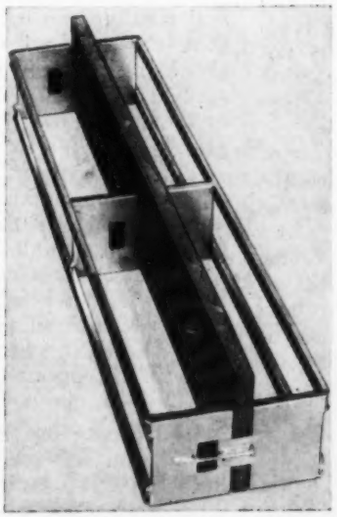

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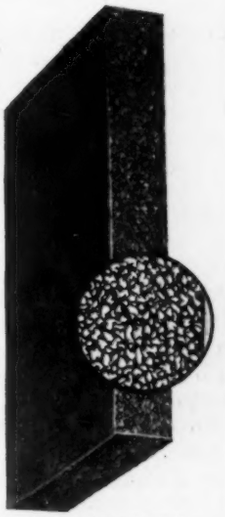

SERVICISED CORK RUBBER JOINT

The improved forms of Servicised Expansion Joints shown here are the Fibre Board, Para-Plastic Joint, Cork Rubber Joint, and the Cor-Rubber Joint.

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Subsoil Drains

The trenches are excavated, generally, with bulldozers or draglines clear through the unstable material to a firm bed. They vary in width from 10 to 12 ft. at the bottom. Slide slopes conform to the material being excavated. The trench has been designed for the lowest point of the firm substrata. On the bottom of the outlet trenches perforated metal pipe 8 in. in diameter is placed and backfilled with about 5 ft. of gravel. Before the compacted backfill is placed a mat of straw is spread over the gravel to prevent dirt from sifting into the gravel pores.

If the saturated subsoil is similar to that in the example given here, shown by Fig. 13, gravel or crushed rock is spread, also, against the side slopes of the trench. Fig. 14 shows these two conditions. Very wet, plastic clay and seepage water are handled by section 8 of this chart.

For more extensive lateral systems from the central drainage trench, trenching like that shown by Fig. 15 is employed. The need for these extensive systems is not usually apparent from a casual inspection of the surface. As a matter of interest, measurements made following heavy rains on this fill indicated a seepage flow of approximately 72 gal. per min. which is 108,000 gal. per day.

General Observations

Although much theoretical knowledge has been developed during the last decade, the fill foundation problem is still the most difficult. Embankment loads are much greater than those of other structures and less susceptible to correct analyses. Determination of the action of large masses of uniform material is difficult in itself. In addition to this the problem becomes much more complex in California because the subsoil beneath the embankments usually consists of heterogeneous material with embankment and subsoil resting on an irregular sloping plane. In the application of the modern theories of soil mechanics, water pressure resulting from heavy loads on saturated, compressible soils has not generally been recognized. This pore (hydrodynamic) pressure will undoubtedly be given more consideration in construction in the future.

At present if foundation engineers obtain a factor of slightly more than 1.00 in their calculations, called the safety factor, they are usually satisfied because it indicates equilibrium of forces acting on incipient slides and slipouts. However, a more desirable safety factor is some value greater than 1.00, such as 1.15, 1.25 or 1.52, with the higher values being used when the hazard from failure is serious. In determining values of "C" and "Φ" from small samples, widely varying results are often secured. Experience and judgment must be employed in adopting usable, probably correct average values.

Substrata drainage is necessary to relieve pore (hydrodynamic) pressure and consolidate saturated impermeable soils. Economic limitations between various designs of drain trenches and vertical sand drains (sand wells) are dependent upon the depth of the overburden and local conditions. It is possible, with proper spacing of drains to get practically all of the settlement within a year's time. A spacing of subsoil drains consistent with the type of material and the desired rate of loading (construction progress) will readily relieve the pore (hydrodynamic) pressure as well as the hydrostatic pressure and thus prevent lateral displacement.

[3] "Combination Foundation Drilling Rig," 1938 Proceedings of the Highway Research Board, Part II, Page 428.

The studies described herein have been carried on over a period of years as a part of the foundation investigational work of the Materials and Research Department of the California Division of Highways under the general direction of Thomas E. Stanton, Materials and Research Engineer. Mr. C. H. Purcell is State Highway Engineer and Chief of the California Division of Highways.

ROAD-MIX SURFACING ON SHOULDERS

In 1936 a road-mix surface treatment was applied to the shoulders on the highway between Ontario and Riverside, Calif. The following details of the work are taken from a paper presented at the 1939 National Asphalt Conference by E. Q. Sullivan, District Engineer, California Division of Highways:

This work was done under contract and the project included treating the shoulders to a width of 6 ft. on each side of the existing pavement to a depth of 5 in., compacted thickness. The length of the project was 14.17 miles and an average of 2½ gal. of Liquid Asphalt SC-2 per sq. yd. was used. The shoulder aggregate was of excellent quality, being of the selected material class.

In advance of applying oil, the shoulders were scarified to the required width and depth and the material was completely broken up by rolling and discing.

The application of oil and the mixing operations were performed by two methods, as follows:

1. Oil was applied in ½ gal. applications and completed with a final application of approximately 1½ gal., applied through a mixing machine of the type that lifted the aggregate from the subgrade and mixed it in a pugmill.

2. Oil was applied in one application through the machine noted in Method No. 1. This machine mixed the material concurrently with the application of the oil.

Approximately 30 per cent of the mixing was done by Method No. 1 and 70 per cent by Method No. 2. Where Method No. 2 was used, the aggregate was windrowed and sized to the cross-sectional area necessary to produce the required width and thickness of compacted shoulder surfacing, and the exact quantity of oil to be applied was determined in advance of mixing operations by the method of "Surface area equivalents of the aggregate."

The total cost of the Liquid Asphalt SC-2 and the cost of preparing, mixing and shaping amounted to $11,819.15. It is noted that this is the cost for 14.17 miles of road-mixed shoulder surfacing, each shoulder being 6 ft. wide and 5 in. in depth. Reducing this to the common basis, it is found that for a 1 in. thickness per mile for a 20 ft. width of surfacing, the cost is $278.03.

Mr. Sullivan stated in his paper that the project had held up exceptionally well.

Conference on Soil Mechanics at Purdue—A conference on soil mechanics and its application will be held Sept. 2-6 at Purdue University, Lafayette, Ind. The conference is sponsored by the Committee on Foundations and Soil Mechanics, Civil Engineering Division of the Society for the Promotion of Engineering Extension Department of Purdue University.

New Course in Soil Mechanics at Cornell—A new course in Soil Mechanics has been opened in the School of Civil Engineering at Cornell University, Ithaca, N. Y., this term by Benjamin K. Hough, Jr., engineer in charge of the district soil laboratory for the U. S. Army Engineer Corps. He was appointed special lecturer in civil engineering.

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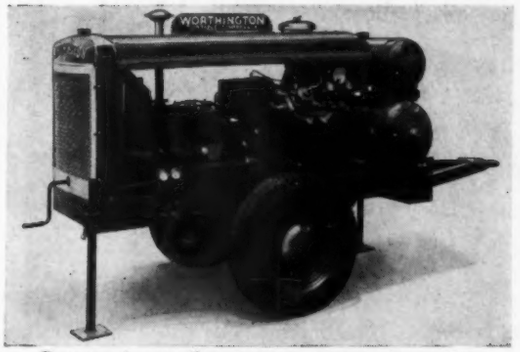

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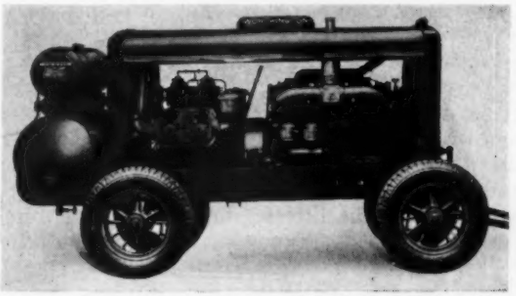

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THE LENGTH OF A GEOLOGICAL "PERIOD"

(Reprinted from an article on "What Geological Periods Should Be" in the Pan-American Geologist, Nov., 1939)

By HALBERT P. GILLETTE

IN PREVIOUS articles of this cycle-series consideration concerned cycles of 189 and 567 years (Pan-American Geologist, Vol. LXX, p. 279, 1938) and 25,515 years (Pan-American Geologist, Vol. LXXI, p. 107, 1939). It was shown that all long cycles were apparently compound in character, built up by the combined effects of short harmonic cycles. Seven series of cycles were discussed. The cycle now to be evaluated is that of the Geological Period, or Geological System, the first term being preferably used by American geologists, and the other title by the British scientists, while the committee of the International Geological Congress suggests a dual scheme one for time and the other for the rocks.

The data at hand indicate that the length of the Geological Period should be 81 times that of the 25,515-year cycle. It will be shown, moreover, that Rutherford's atomic-disintegration formulas of the rock ages must be grossly erroneous. Varve and strata measurements seem to make this certain. The term varve is here used to denote either a single, or a double layer of lacustrine, or marine, sediments, deposited in a year. It may be well to note that the existence of such annual layers has much to commend it, for the same cycles are to be found in varves that occur in growth-rings of trees, and in temperature and rain-fall, *e.g.*, cycles of three, five, and seven years, and triple-progression multiples thereof.

Although the thickness of strata deposited in a given Period often seemingly varies greatly in different regions, there is surprisingly small variation between the maximum thicknesses in the different Periods. Evidently in regions where conditions were ideal for sedimentation there was substantial uniformity as to the thickness. This fact has often been concealed by the grouping of two Periodic sedimentations under a single name, *e.g.*, the Carbonic and the Cretacic. Each of these two systems has been divided into a Late and an Early group that some geologists regard as separate Periods. In the accompanying table the Carbonic and Cretacic are each split into two Periods, for it will be seen that by doing so not only are their maximum thicknesses similar to those of the other Periods, but that another and greater cycle discloses itself. This greater cycle may be called an Era the length of which is three Periods. The peak of precipitation, sedimentation and uplift of an Era is marked by a Geological Revolution. With the exception of the Alpine revolution, the other seven revolutions are those given by Schuchert, in *The Evolution of the Earth.* He regarded the Laramide revolution as greater than the Alpine, but in doing so he is wrong.

The maximum rock thicknesses are those given by Sollas (Quart. Jour. Geol. Soc. London, Vol. LXV, 1909), excepting as to the Jurassic which he gave as 5,000 ft. Subsequently it was found to be 14,000 ft. thick, in China. To his Period thicknesses are here added those of the Huronic, the Animikean and the Keweenawan.

Based on recent erosion and sedimentation rates, Sollas estimated about 100 years to the foot of rock, at which rate we arrive at about 1,750,000 years for a Period.

Stamp (Geological Magazine, Vol. LXII, p. 515, 1925) says, "A million years has sometimes been regarded as a mere bagatelle in geological time. In Burma it has been sufficient for the deposition of between 5,000 and 10,000 ft. of sediments. . . . The duration of the Oligocene and half the Miocene is probably in the neighborhood of 2,500,000 years." Hence the length of a geological period is of the order of 1,700,000 years according to Stamp's estimate, based on varves.

A search of geological literature has brought to light average thicknesses of rock-varves as given by only 9 authorities, as follow:

David (Australian Carbonic)	average number per foot	60
Krige (African Dryka)		100
Gillette (California Tertic)		120
Marr (English Ordovicic)		140
Stamp (Burma Tertic)		174
Udden (Texas Permian)		185
Rubey (Wyoming Cretacic)		1500
Bradley (Colorado Eocene)		2200
Ashley (Cannel coal, Laredo, Texas)		3000

Lawson's laminæ, near San Francisco, which are about 2 in. thick, are omitted, for I find that the varves in them are about one-tenth of an inch thick.

The following are typical thicknesses of unconsolidated varves deposited in either ancient, or existing, lakes:

Antevs (Timiskiming, Canada)	average number per foot	22
Antevs (Massachusetts)		27
Emerson (Massachusetts)		30
Reeds (New Jersey)		55
Johnson (Lake Louise, Canada)		60
Perfiliev (Lake Saki, Crimea)		250
Whittaker (Mackay lake, Ottawa)		720

My California measurements of varves in rocks have been made in scores of beds between Los Angeles and San Francisco. The average of ten, or more, rock-varves in sequence seldom differ much from an eighth to a tenth of an inch per varve. These are marine sediments and they are far more uniform in thickness than lacustrine sediments usually are. By the aid of these California rock-varves I have found the lengths of several long cycles that are recorded by pairs of beds of sandstone and shale, as stated in previous articles.

In the accompanying Table I it will be seen that the thicknesses of 12 of the 18 Periods differ from 15,000 ft. by 20 per cent or less. Applying the binomial

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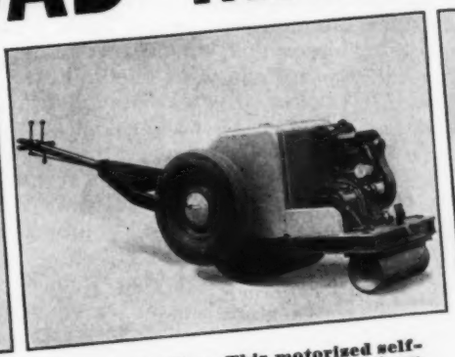

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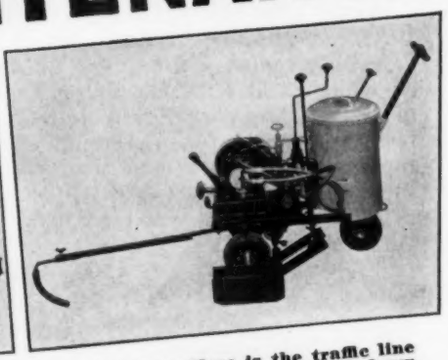

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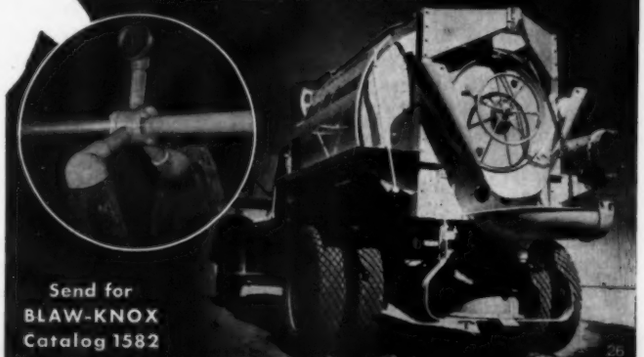

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formula of probability to this fact, the odds of nearly 70 to one are against such uniformity being accident. This amounts to satisfactory proof that the length of a Geological Period is either constant or nearly so. That it is constant, I have little doubt, because analyses of long series of varves and growth-rings of trees show that the lengths of short cycles are constant, and that the short cycles are harmonics of longer cycles. Since this is certainly true of cycles up to the 567-year cycle, it is probably true of longer cycles, no matter how long.

Weller (Journal of Geology, Vol. XXXVIII, p. 98, 1930) was the first to show that in the Late Carbonic, or Pennsylvanian, Period there is a subcycle the number of which is at least 42. But since the coal-beds that mark the warm part of this cycle do not occur throughout the Pennsylvanian, it follows that the number of these subcycles must considerably exceed 42. Study of the data indicates that this coal cycle is the 25,515-year cycle discussed in a previous article, and that 81 of these subcycles occur in a Geological Period.

Evans & Stubblefield (Handbook of Geology of Great Britain, London, 1929) give the number of graptolitic zones in the Siluric period as 40, but where they are most numerous the spacing indicates that the total number would be at least 72 if all subdivisions of the Siluric section were equally well represented. The ammonite zones in the British Jurassic section lead to a similar conclusion. It is safe to infer from such facts that fully 72 subcycles exist in a Period. Since triple-progression is characteristic of cycles, it is inferred that there are 81 (or 3 to the 4th power) subcycles in a Period. If so the length of a Period probably is 81 x 25,515 = 2,066,715 years.

The last rain-fall peak and temperature minimum of a Period probably was in 66,923 B.C., which was also a peak of its subcycle of 25,515 years. The 25,515-year cycle has short subcycles whose epoch-dates and lengths are determinable with precision by means of the 4,200 varves, measured by Schostakowitch, in Lake Saki, in the Crimea. As shown in a previous last article there have been only three peaks of this 25-515-year cycle in Quaternic time, designated respectively as the Nebraskan, the Kansan and the Wisconsin ice epochs, Near rain-fall peaks of a Geological Period, peaks of the 25,515-year cycle are marked by ice epochs; whereas near-dry valleys of a Period, valleys of the 25,515-year cycle are often marked by deposits of carbonaceous matter, such as petroleum, coal, or carbonaceous shale. Hence the 25,515-year cycle may, with equal propriety, be called either an ice-age cycle or a carbonic cycle.

In a previous article, also, it was neglected to mention that certain geologists have erroneously inferred that the length of time between the Nebraskan and Kansan ice-peaks was much longer than between the Kansan and Wisconsin peaks. This error arose from the use of erosion rates between those peaks in certain valleys. Precipitation was a maximum at the Nebraskan peak, and attained successively lower maxima at the Kansan and Wisconsin peaks. Since run-off is a function of precipitation, and erosion is a function of run-off, it follows that in a narrow valley the floods were much greater between the first and second peaks than between the second and third peaks of the 25,515-year cycle. Hence, if valley erosion rates are used as criteria of length of this cycle very erroneous conclusions result. The constancy of length of this cycle is well shown by the spacing between centers of coal-beds and oil-sands. In those cases sedimentation usually occurs over extensive areas.

J. E. Marr (Paleobiologica, Vol. I, p. 161, 1928) measured varves in the Lower Ludlow division of the English Silurian system. He found an average of 140 varves to the foot, as to which he said: "The striped (varved) structure ranges fairly generally throughout the deposit." This deposit is the Bannisdale slates that have a maximum thickness of about 5,000 ft., which is about one-third of the maximum thickness of the English Siluric rocks. Hence it is inferred that the length of the Siluric Period is about 140 x 15,000 = 2,100,000 years.

Additional facts could be cited to show that the length of a geological Period is of the order of 2,000,000 years. Table I shows 18 such Periods since the Algomian revolution, and about 173,000 feet of rock below it. This indicates about nine Periods before the Algomian revolution, making a grand total of 27 Periods in the geological scale. 27 x 2,067,000 = 55,809,000 years. Hence the age of the oldest stratified rocks is of the order of 56 million years, instead of the 2,000 million years, or more, that the Rutherford atomic disintegration formulas indicate.

Using the present rates of conveyance of chlorine to the sea, Joly estimated the age of the sea to be 80 to 100 million years. Some advocates of the Rutherford formulas have tried to explain away the glaring discrepancy between observed facts, such as Joly has marshalled, and the theoretical deductions from the lead-uranium and helium-uranium formulas; but their *ad-hoc* hypotheses never have been very plausible. Now we have evidence furnished by varves (such as that first published by Stamp) overwhelmingly condemning the reliability of the Rutherford formulas. Moreover, a careful study of some of the deductions from those formulas discloses gross inconsistencies. For example, using the rock thicknesses in Table I, and the lead-uranium formula as applied by Holmes, we get 660 years to the foot of rock in the Tertic column, as compared with 5,500 years to the foot of rock above the base of the Devonic section.

TABLE I—GEOLOGICAL PERIODS AND REVOLUTIONS

	Maximum Thickness, Feet
Cascadian Revolution	
Pliocene	13,000
Miocene	14,000
Oligocene	12,000
Alpine Revolution	
Eocene	20,000
Late Cretacic	22,000
Early Cretacic	22,000
Sierra Nevada Revolution	
Jurassic	14,000
Triassic	17,000
Permian	12,000
Appalachian Revolution	
Late Carbonic	14,000
Early Carbonic	14.000
Devonic	22,000
Caledonian Revolution	
Siluric	15,000
Ordovicic	17,000
Cambric	26,000
Grand Canyon Revolution	
Keweenawic	29,000
Animikic	14,000
Huronic	18,000
Algomian Revolution	
Lower sedimentary rocks	173,000
Total sedimentary rocks	489,000

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TABLE II—MAXIMUM THICKNESS OF STRATA COMPARED WITH THOSE GIVEN BY GILLETTE FORMULA

	Actual Thickness	Formula Thickness
Oligocene and above	40,000	56,000
Eocene and above	60,000	85,000
Carbonic and above	174,000	190,000
Devonic and above	196,000	202,000
Lower Archæan and above	489,000	403,000

The Gillette formula is $T = 11{,}000 \sqrt{A}$; in which T = maximum thickness in feet, A = age in millions of years as deduced from the lead-uranium formula by Holmes (Nature, 1925, p. 891, and "*The Earth*" by Jeffreys).

The lead-uranium formula is

$A = K P/U$

A = age of rock in years

P = weight of lead

U = weight of uranium

K = constant whose value is 7,500,000 according to Barrell.

I find that the following formula approximately fits the facts as disclosed by varve measurements:

$a = k \sqrt{P/U}$

a = age of rock in years

k = constant of about 3,700,000.

In order to show that this formula gives approximately the same maximum thickness of rock for the different Geological Periods (as shown in Table I) Table II is computed.

It is inferred from the substantial agreement between my empirical formula and the facts presented in Table II that the atoms that result from the decomposition of the uranium act in a somewhat catalytic manner to hasten that decomposition. Since the helium is occluded by the rock, its mass steadily increases. The mass of the lead also is constantly increasing in the rock.

Since the causes of the decomposition of uranium are unknown, it is unsafe to assume that its rate of decomposition in rocks millions of years old is the same as in the laboratory. Bearing upon the uncertainty as to the nature of this decomposition, Dr. Watson Davis (Science News Letter, Vol. XXXV, p. 86, 1939) recently said: "The radioactive time-clock method of determining the age of the Earth may be proved wrong if uranium can be split up in the strange new manner." He referred to Prof. Otto Hahn's sensational discovery that bombardment of radium by high-speed particles produces barium instead of lead.

In previous articles I have touched upon a solar and terrestrial electronic emission theory of cycles, and have indicated how electronic forces may cause not only weather and climatic but diastrophic and magnetic cycles. Certain correlations between these three types of cycles were established by mathematical probability calculations. Further investigations may lead to much more complete understanding of diastrophism. If so, another instance will have been added to the many in scientific history showing how illuminating careful measurements of data may be. In this connection too much stress can not be put upon the use of mathematical probability, not only in deriving empirical laws but in testing the truth of a scientific theory.

Nature abounds in mathematical laws. Therefore the ogical presumption should be that even where chaos appears to be rampant, as in weather and in crustal movements, there is an underlying orderliness which has been conceaied from us only by the complexity of the forces and by our failure to search for electronic causes. Electronic theory has already revolutionized physics and chemistry. Hence, there is at least a reasonable prospect that electronic theory may revolutionize geology.

SPECIFICATIONS FOR MATERIALS FOR STABILIZATION

Two proposed new tentative specifications for materials for stabilized base course and for surface course have been referred to letter ballot by Committee D-4 on Road and Paving Materials, of the American Association for Testing Materials.

The scope of the proposed new specifications is as follows: These specifications cover the quality and size of sand-clay mixtures; gravel, stone or slag screenings, or sand, crusher run coarse aggregate consisting of gravel, crushed stone or slag combined with soil mortar or any combination of these materials for use in the construction of a stabilized base course(or stabilized surface course). The requirements are intended to cover only materials having normal or average specific gravity, absorption and gradation characteristics. Where materials such as caliche, gypsum, limerock, and water soluble salts are to be used appropriate limits suitable to their use must be specified. Three types of base (or surface) stabilized mixtures are specified; namely, sand-clay mortar; coarse graded aggregate; and gravel, stone or slag screenings or sand.

It is expected these specifications will be published in the annual report of the committee for submission to the Society at its Atlantic City meeting.

Officers of Committee D-4 on Road and Paving Materials are Chairman: E. F. Kelley, Chief, Division of Tests, Public Roads Administration, Washington, D. C., and Secretary: Prevost Hubbard, Chemical Engineer, The Asphalt Institute, New York City.

W. H. CULLIMORE NEW ENGINEER-SECRETARY NATIONAL PAVING BRICK ASSOCIATION

William H. Cullimore, heretofore associate engineer of the Department of Public Works of Baltimore, Md., has been appointed engineer-secretary of the National Paving Brick Association, Washington, D. C. He succeeds the late George F. Schlesinger, who held the position for the past 12 years.

Mr. Cullimore was born in Baltimore on March 20, 1900, was educated in the Baltimore schools and was graduated from Baltimore Polytechnic Institute in 1918. After two years of study in the civil engineering course at Johns Hopkins University, he spent nearly three years with the paving commission of Baltimore. He left Baltimore in 1923 to become office engineer with the highway department of Greensboro, N. C., and was later promoted to assistant highway engineer. In 1925 he returned to Baltimore as assistant to the sewerage engineer of the bureau of sewers and was then transferred to the position of associate civil engineer of highways in the city bureau of highways. In 1935 he was appointed to the post in the chief engineer's office which he held until accepting the secretaryship of the National Paving Brick Association. An associate member of the American Society of Civil Engineers and an active member of the American Road Builders' Association, Mr. Cullimore is also vice-president of the Maryland Association of Engineers. He is a frequent contributor to engineering publications and has given a number of addresses at meetings of highway organizations.

Nathan L. Smith Opens Consulting Office—Nathan L. Smith, formerly highways engineer of Baltimore City and Chief Engineer, Maryland State Roads Commission, has opened a consulting engineer's office at 1201 St. Paul St., Baltimore, Md.

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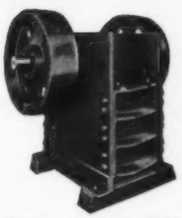

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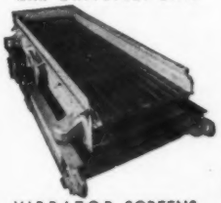

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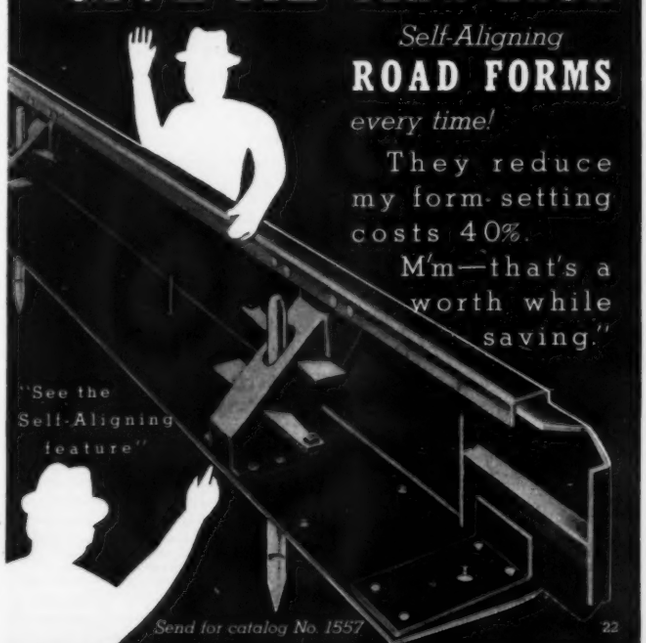

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Self Aligning **ROAD FORMS**

TRENDS IN HIGHWAY GRADING COSTS

HOW changes in construction equipment have reduced the cost of highway grading was pointed out by F. A. Nikirk, Civil Engineer, Caterpillar Tractor Co., in a paper presented at the 1940 Colorado Highway School at the University of Colorado. The following is abstracted from his paper. The effect of these changes is shown in Fig. 1. Here, the year 1923 is considered as typical of the period of manual labor and animal power and therefore taken as a base equal to 100 for comparison with subsequent years for both the cost per hour of common labor and the price bid per cubic yard for highway grading on federal-aid projects. The lower solid line of the graph shows a downward trend in the going price of earth moving until the average unit price bid in 1938 was but 45.7 per cent of that bid in 1923, while the average hourly wage paid for common labor increased to 130.8 per cent of that paid in 1923. There has been a steady increase in the amount of skilled and semi-skilled labor employed in highway grading at a much higher hourly wage than that of common labor. Taking this into consideration, it is safe to say that the average hourly wage paid for all labor on highway grading has doubled during the period under discussion.

While the amount of labor employed on the job, per unit of work done, has been decreased, the amount of off-job labor that has been put to work because of highway expenditures has greatly increased. Studies undertaken by the Public Roads Administration indicate that 75c of every highway dollar go to the employment of labor either on the job or elsewhere and if the investment and re-investment of the other 25c (which goes to interest, sinking funds, profits, etc.) be considered, the entire highway dollar ultimately goes to labor. When we consider that working conditions on the job have greatly improved and off-job labor is often employed under still more favored circumstances, it is easy to see why the social and economic benefits of the highway industry have been felt in every city, town and hamlet of the country.

It is also evident that through the decreasing unit cost of construction the traveling public receives more and more in highway facilities for the invested dollar. This in turn invites more traffic and renders economically sound the expenditure of increasing amounts for highway construction. The question then remains, How far can this reduction in cost continue? Obviously, it cannot go on indefinitely at the present rate.

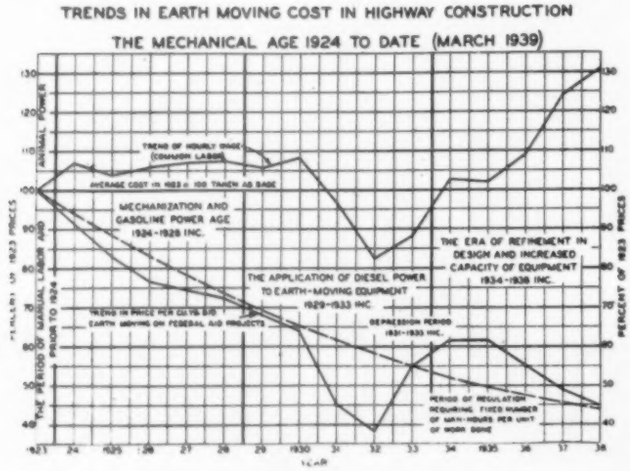

TRENDS IN EARTH MOVING COST IN HIGHWAY CONSTRUCTION
THE MECHANICAL AGE 1924 TO DATE (MARCH 1939)
MECHANIZATION AND GASOLINE POWER AGE 1924-1928 INC.
THE APPLICATION OF DIESEL POWER TO EARTH-MOVING EQUIPMENT 1929-1933 INC.
THE ERA OF REFINEMENT IN DESIGN AND INCREASED CAPACITY OF EQUIPMENT 1934-1938 INC.
DEPRESSION PERIOD 1931-1935 INC.
PERIOD OF REGULATION REQUIRING FIXED NUMBER OF MAN-HOURS PER UNIT OF WORK DONE
PERCENT OF 1923 PRICES
YEAR

Fig. 1

Major Causes of Reduction of Cost

The two major causes for the reduction of cost of highway grading are:

First, the improvement in the mechanical efficiency and the economy of operation of equipment.

Second, the improvement in methods used in handling the work. Let us assume these two factors to be operating independently of any outside influences or regulations and at a rate sufficient to reduce the cost 60 per cent in 20 years. One would normally expect the most rapid decrease to occur when the cost is highest and that the reduction of cost would continue at a decreasing rate until the ultimate is reached. Such a trend is illustrated by the parabolic curve shown by the broken line in Fig. 1. These purely arbitrary assumptions are made solely for the purpose of comparison with what has actually happened in the trend of earth-moving prices during the first 15 years of a 20-year period.

It appears that the actual prices bid on federal-aid projects remained slightly below those shown on the theoretical curve until the depression, when a rapid decline occurred. The return from depression, combined with adoption of rules requiring a fixed number of man-hours per unit of work done, caused an upturn in the price of earth work. The only time that the bid price exceeded the normal tendency, as shown by the broken line, was during the period when such regulatory measures were in force. It is interesting to note that, as the pressure of regulation was released, the price bid rapidly approached the assumed curve for normal variation.

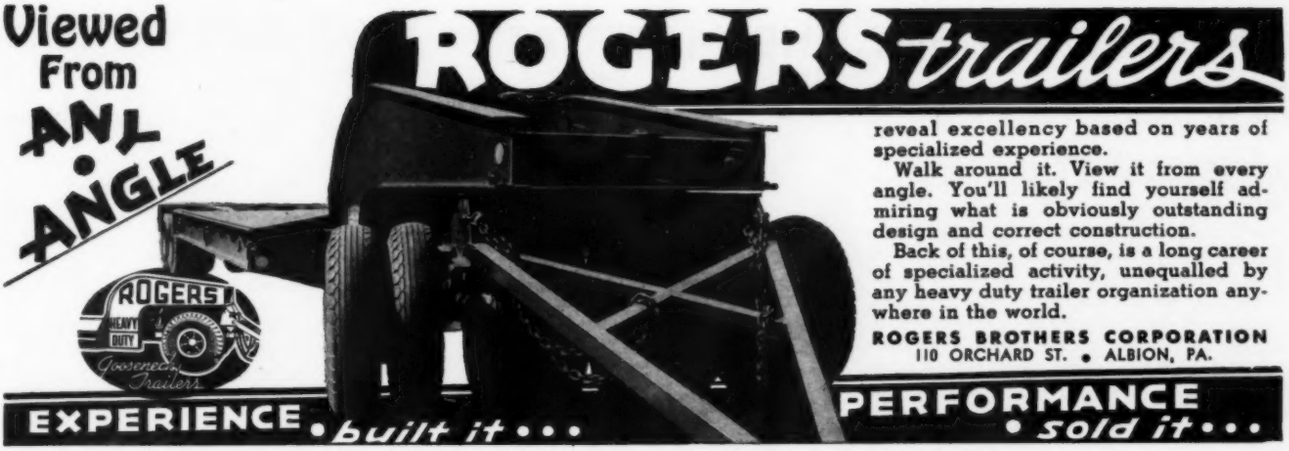
Having examined the success already achieved in increasing the production rate for construction equipment, the upward trend in the hourly wage for labor and the downward trend in the price bid for earth moving, one is forced to the inevitable conclusion that the salvation of the industry lies in the intelligent and extended use of the fundamental principles of scientific management.

UNUSUAL FROST CONDITIONS IN MISSOURI

Following the extremely cold weather during January and early February, maintenance crews of the Missouri State Highway Department took soundings to determine the frost depth on the state road system. Some unusual frost conditions were located. It was found that on an average the frost extended to a depth of approximately 20 in. The most severe frost conditions existed in the counties north of U. S. Route 36, between St. Joseph and Hannibal, where the frost in several instances penetrated 42 in. The minimum frost penetration in the southern counties reported was 8 in.; the maximum 23 in.

Effect of Acid Mine Waters on Cements—Information of interest in connection with the use of cements for highway bridges and culverts and for many other structures in places where waters of the generally recommended quality are not available for mixing, and especially where the construction must withstand contact with acid mine waters is given in "Report of Investigations 3487" which may be obtained from the Bureau of Mines, Washington, D. C.

Viewed From ANY ANGLE



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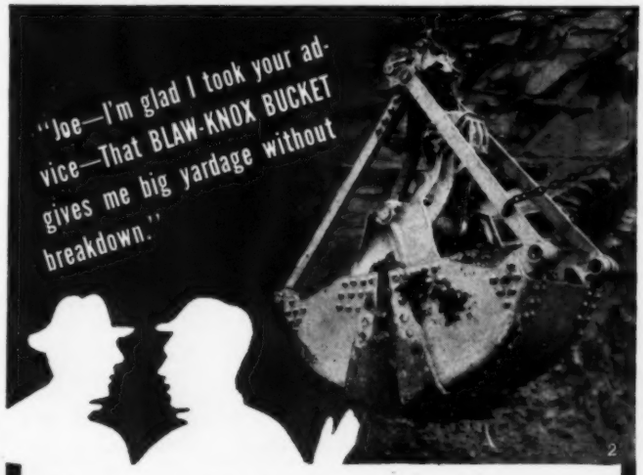

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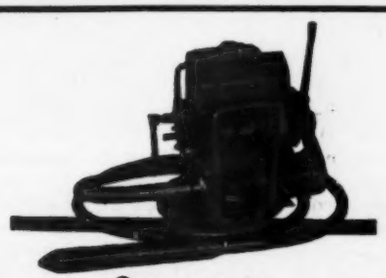

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NEW EQUIPMENT AND MATERIALS

New Portable Quarry Plant

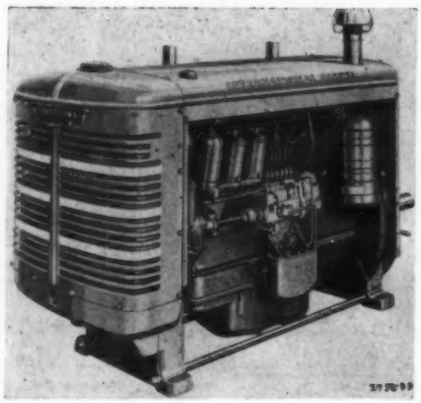
A new quarry unit brought out by Diamond Iron Works, Inc., and the Mahr Mfg. Co. Division, Minneapolis, Minn., receives rock direct from the quarry shovel dipper to the receiving hopper. A 30 in. x 5 ft. apron feeder with manual control discharges over a grizzly screen, the oversize quarry rock to a 15 x 24 jaw crusher, and the undersize is by-passed to the belt conveyor passing under the jaw crusher. The jaw crusher also discharges to the belt conveyor mentioned above. This conveyor delivers all material to the large vertical rotor-lift that elevates the product to the main conveyor for delivery to the 4 ft. x 8 ft. single deck Diamond vibrator screen. Sized material passes the screen to the hopper below that feeds the delivery belt conveyor. Oversize is discharged to a 26 in. x 20 in. roll crusher and carried back by a belt conveyor to the vertical rotor-lift for recirculation over the screen. This plant can be equipped with a double or tripple deck screen and chip

New Diamond Iron Works Quarry Unit

eliminator when desired. The outfit is equipped with dual pneumatic tires and mechanical brakes. It is a self contained unit driven by a 90 to 100 H.P. diesel engine mounted overhead or from an auxiliary engine.

New 100-H.P. Diesel Power Unit

A new 6-cylinder diesel power unit which develops 100 H.P. power at 1400 r.p.m., has just been announced by the International Harvester Co., 180 North Michigan Ave., Chicago, Ill. As in the case with other International diesels this new Model UD-18 engine is provided with a distinctive method of starting by which it starts on gasoline and, after a minute or less of operation, shifts to full diesel operation. It can be cranked by hand as easily as a gasoline engine of same size. An inexpensive standard 12-volt electric starting system may also be utilized to provide electric starting. The new power unit is of rugged compact construction and is provided with heavy, large-diameter flywheel. It has ample weight (approximately 3,875 lbs. less fuel, oil, and water) and reserve strength for heavy-duty service. Cylinders are individually replaceable and are specially heat treated. Cylinder bore and strokes are respectively 4¾ and 6½ in. Piston displacement is 691 cu. in., regular full-load governed speed 1,400



International UD-18 Diesel Power Unit

r.p.m., and maximum torque 430 pounds-feet at 800 r.p.m. The 7-bearing crankshaft is a heavy alloy-steel drop forging. In addition to the usual heat treatment, it is Tocco hardened. This is a high-frequency electrical induction process which provides file-hard bearing surfaces, while the rest of the shaft retains its ductility and toughness. All bearings are replaceable and are diamond-bored to assure accurate size and shape and long life. A thermostatically controlled cooling system of large capacity and full pressure lubrication through drilled passages also assure efficient and economical operation. The clutch is of the heavy-duty over-center type. It is 17 in. in diameter and has 312 sq. in. of friction facing area. It locks in or out of engagement. When clutch is disengaged, springs positively free a lightweight driven disk which is splined to the power take-off shaft. Clutch torque capacity is 1,488 pounds-feet. Over-all length of the new power unit is 95⅞ in.; width, 35⅞ in.; and height, 61 11/16 in. Crankcase pan oil capacity is 22 U. S. quarts, and cooling system capacity is 26 U. S. gallons.

New Whiteprint Machine

A new automatic high speed whiteprint machine brought out by the Ozalid Corporation, Ansco Road, Johnson City, N. Y., employs a new quartz envelope high pressure mercury vapor lamp, which is stated to provide an extremely fast printing speed, ranging up to 20 lin. feet per minute, and to assure uniform distribution over the entire printing surface. This lamp, guaranteed for 1000 hours, is new to the reproduction industry, and has been designed and manufactured especially for this machine. The machine is available in two sizes for production of prints up to and including 42- and 54-in. widths. An ingenious device automatically separates the print from the original after exposure. The original is returned to the operator in front of the machine, while the exposed print is automatically conveyed to the developing unit, where after dry development, it is discharged at the rear of the machine ready for immediate use. A variable transformer in the primary circuit permits a variation of intensity of the high pressure mercury vapor lamp from full brilliancy to 60 per cent of light without loss of energy. This dimming arrangement is extremely important, for it allows the operator to select the desired intensity, and permits continuous and uniform production of prints, despite variations in tracings. The high pressure mercury vapor lamp is cooled by an alternating air blast, which passes through the space between the revolving contact cylinder and the fixed cylinder surrounding the quartz envelope high pressure mercury vapor lamp. By alternating the cooling air stream, high temperatures between the left and right sides of the contact cylinders are avoided. A small, metered quantity of cooling air is

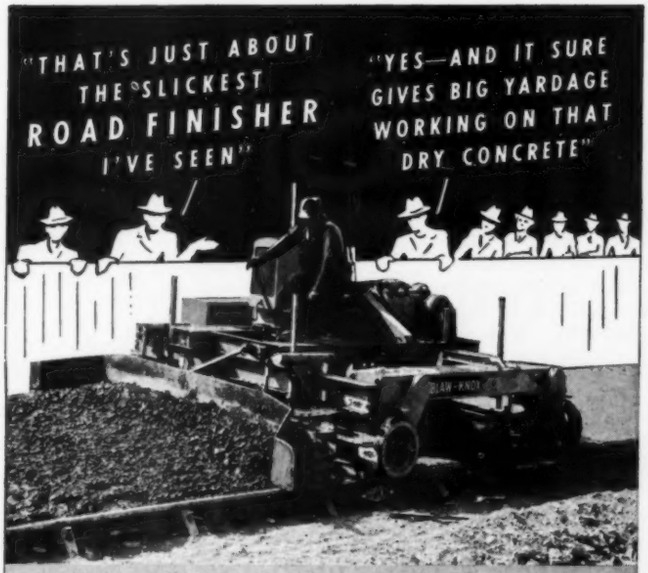
Ozalid Model A Automatic High Speed Whiteprint Machine

also allowed to enter and pass through the inner cylinder and over the quartz tube; thus, the temperature of this lamp is maintained within a relatively small range.

New Mower Has Cutting Discs

A new type mower stated to be capable of cutting through field growths at speeds up to 20 miles per hour has been brought out by the Bishop Rotary Mower Co., Arcadia, Fla. The mower unit is built integrally into a Ford pick-up chassis having a Ford V-8 Mercury engine.

Starting with a standard chassis, the manufacturer shortens the wheelbase 1 ft., then installs an auxiliary drive shaft down one side. Power is transmitted to the auxiliary drive shaft by means of V-type friction belt operating on a pulley attached to the front end of the engine crank shaft. This arrangement necessitates placing the fan on the generator which, in turn, requires that the radiator be raised. Two openings are cut in the hood to supply air to the radiator in its raised position. The power from the auxiliary drive shaft is transmitted to three perpendicular shafts, set midway of the chassis, by means of additional pulleys and V-type friction



If you're on the fence about buying a road finishing machine this season it will definitely pay you to get full information about this *new* Blaw-Knox ROAD FINISHER.

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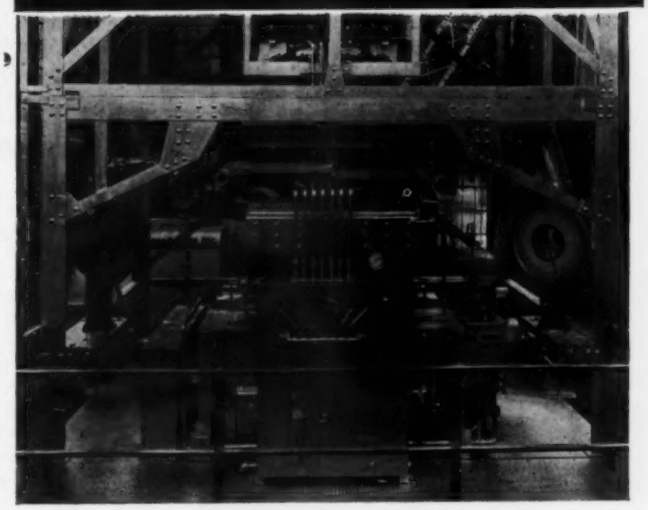

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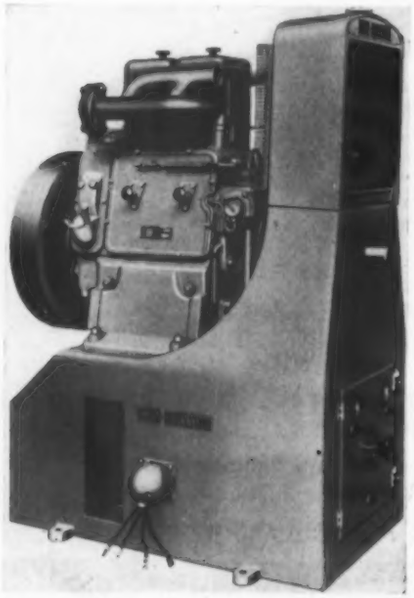
Close-up of Bishop Rotary Mower Showing Rotating Discs

belts. At the lower end of each shaft is a disc fitted with ordinary mowing machine knife sections. When the machine is in operation the discs rotate in a horizontal plane and cut a swatch 7 ft. wide. At 8 miles an hour they rotate at 850 revolutions a minute and at 20 miles an hour, at 1700 revolutions per minute. A clutch is conveniently located on the auxiliary drive shaft for starting and stopping the discs. Ample protection is provided against hidden obstacles. The shafts to which the discs are attached "float" so that the latter will ride up and over uneven ground surfaces. If the cutting discs strike projections which cannot be cut, the belts slip permitting them to ride around the obstacles without damage to the machinery. In extreme cases the knife sections break off. They are attached to the discs with cold rivets and are easily replaced in the field. The discs may be set for cutting from ground level to 8 in. in height.

New Diesel Electric Generator Set

A new line of diesel-electric power plants, ranging in size from 3600 to 24,000 watts and built to a simple, yet revolutionary space-saving design, has been placed on the market by Lister-Blackstone, Inc., 1706 South 68th St., Milwaukee, Wis. These new plants consist of a radiator cooled engine, generator and control panel, all assembled in compact form, ready to set in place and put to work. Chief change from conventional design is in the placement of the generator, which sets directly underneath the engine and thus cuts floor space requirements almost in half. Power for generating is supplied by the Lister-4-cycle diesel engine using Bosch fuel system. To assure long engine life, the cylinder walls are chromium impregnated by the Listard process. The patented dual-compression system used on Lister-Diesels, makes starting by hand easy under all temperature conditions, without the use of punks, glow plugs, or any other preheating devices, according to the manufacturers. Generators are available in any desired voltage or current, either D.C. or single or three phase A.C., for stationary or marine service.



"Powr-Pak" Diesel-Electric Power Plant

New Crane

A new crane brought out by The General Excavator Co., Marion, Ohio has a specially designed wheel mount equipped with dual rubber tires. It is claimed that the crane will lift and swing a load of 6,000 lbs. in a full circle—50 feet from the machine—without danger of tipping or breakdown. The basic structure of the

New General Crane Showing Specially Designed Wheel Mount Equipped with Dual Rubber Tires

dual-tire wheel mounting is engineered of 20-in. I-beams running the full length of the carriage, and is designed to support 100 tons dead weight. The crane is self-propelling. It requires only one engine, one operator, one set of controls. Alloy steel axles are 6 in. in diameter. Stout outriggers are designed as integral parts of the understructure. Extended and locked securely into position, these outriggers greatly increase the machine's stability. They fold compactly against the sides of the understructure for transportation. Other features claimed for the crane include: ability to handle up to 100-ft. booms, or an 80 or 90-ft. boom with 20-ft. adjustable jib for "goose-necking" over walls; fast, worm wheel type boom hoist completely independent of swing clutches. Loads are lowered through the gears and under control every inch of the way through a specially designed auxiliary precision brake. The crane also possesses the ability to hoist and swing at the same time, with two separate and equally effective brakes on both hoisting and swinging operations. In addition, there is a special travel brake that will bring the 24-ton machine from top speed to a dead stop in about 10 ft.

New Hard Facing Electrodes

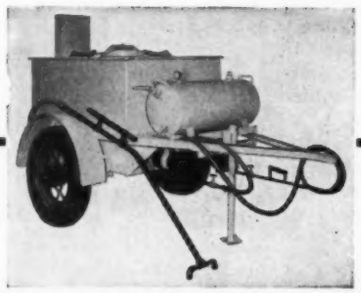
Two new hard facing electrodes, "Faceweld No. 1" and "Faceweld No. 12," have been announced by The Lincoln Electric Co., 12818 Coit Road, Cleveland, O.

These electrodes are cast abrasion-resisting alloys used for hard-facing by the metallic arc process. Both are coated electrodes, have exceptionally good arc characteristics and produce a smooth dense deposit. Deposits are very resistant to abrasion but not excessively hard and brittle. "Faceweld" bonds well with all types of ferrous alloys. "Faceweld No. 1" is a general purpose hardfacing electrode and is the softer and tougher of the "Facewelds." It has good abrasion resistance and very high resistance to impact for this class of material. "Faceweld No. 1" is used for surfacing such parts as digger teeth, scarifiers, grader blades, cement plant machinery, etc., by arc welding. "Faceweld No. 12" is applied by arc welding and is somewhat harder than "Faceweld No. 1" and has superior resistance to abrasion. Its resistance to impact is excellent for this type of material but not quite as high as "Faceweld No. 1" in this respect. Applications include screw conveyors, conveyor sleeves, plows, gyratory crushers, power shovel and dragline bucket parts, dredge pump impellors and casings, coal pulverizer jaws, cement mill machinery, such as Bradley and Griffin rings, crusher roll plates, etc.

New 22-H.P. Power Unit

A new 22 H.P. power unit has been announced by the International Harvester Co., 180 North Michigan Ave., Chicago, Ill. It is a compact, 4-cylinder, valve-in-head engine, with 3-in. bore and 4-in. stroke. It develops 22 net horsepower when operating on gasoline at regular full-load governed speed of 1800 r.p.m. Equipment for operation on natural gas, distillate, or kerosene is also available. Combination chamber is shaped to give complete con-

New Model U-2 Power Unit



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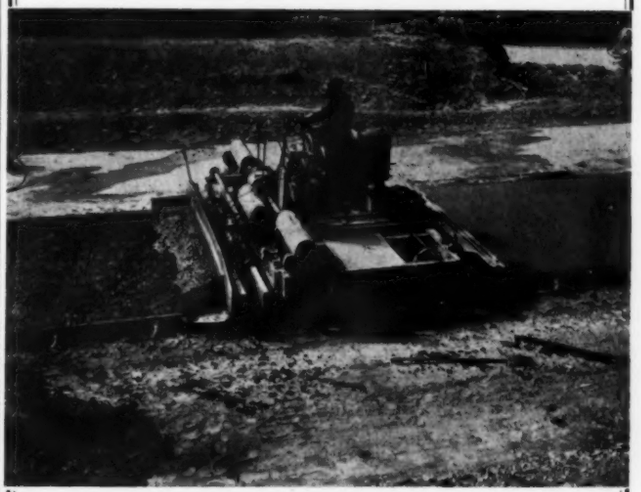

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ROADS AND STREETS

is the only national magazine in the engineering construction field devoted exclusively to promoting the interests of all sections of the *highway field*, and the only publication confining its circulation exclusively to coverage of the economic specifying and buying power in that field.

trol of rate of combustion and prevent engine "knocking." Low fuel consumption with maximum power output and increased engine life result from this combustion control. An oil filter with an inexpensive, highly efficient, replaceable element keeps the oil clean and makes it possible to use the oil a long time without change. A gear-type pump delivers oil under pressure to the engine parts through drilled passages. Main and connecting-rod bearings are of the easily replaceable precision type. The crankshaft is electrically hardened by the Tocco method—a high-frequency induction process that makes the bearing surfaces file hard but leaves the rest of the shaft tough and strong to withstand stresses. Cylinders are easily replaceable with exact duplicates which make longer engine life possible. The governor is of the lever-adjusted, variable-speed, fly-ball type and has full control of the throttle at any engine speed from 1000 to 1800 r.p.m. Governor springs giving close regulation at 1200 r.p.m., as required for generator service, are available. Bore and stroke are respectively 3 in. and 4 in. and piston displacement is 113.1 cu. in. Maximum net torque is 78 pounds-feet at 1000 r.p.m. The single-plate clutch is 9 in. in diameter and is of the over-center type. A spring-loaded clutch is also available. Approximate weight of the new U-2 (less fuel, oil, and water) is 665 lb. Over-all length is 50 11/16 in.; width, 20 5/8 in., and height, 40 1/4 in.

New ½ Yd. Shovel

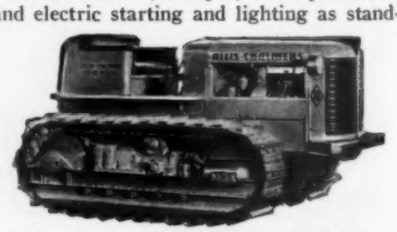
A new, full-size ½-yd. convertible shovel-dragline-crane, Model LS-60, has been announced by Link-Belt Speeder Corp., 301 W. Pershing Road, Chicago, Ill. Claimed for this new model are several advancements, which include self-aligning roller bearings on drum shafts, reverse shaft and main power shaft; a new safety-type rapid boom-hoist for crane duty, with conventional worm-geared boom-hoist optional; fully enclosed traction gears running in oil; double fully-enclosed traction brakes controlled from the cab; a 56-in. machine-finished roller path turntable with roller bearing "hook" rollers; interchangeable clutches on drum, swing, retract and boom hoist; welded steel design for strength and resistance to shock load and to provide positive alignment of machinery

New Link-Belt Speeder Shovel

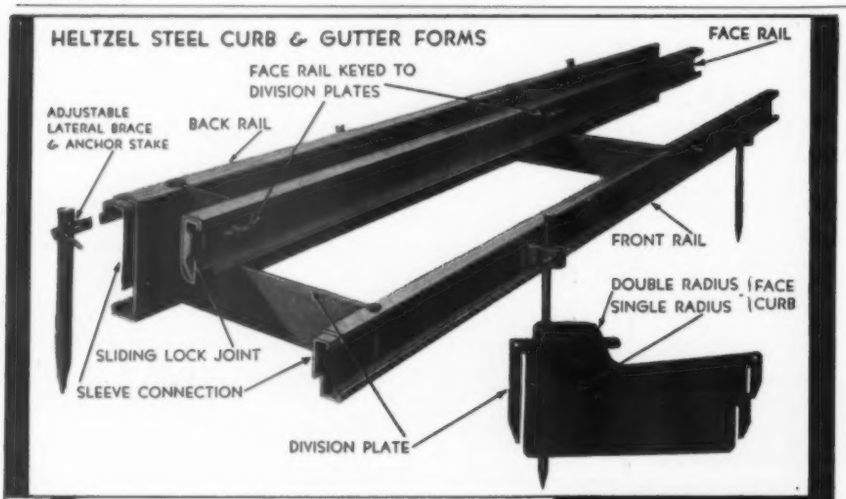
parts; glass all around in operator's cab. The engine is 60-H.p., gasoline or diesel. Track shoes are 16-in. standard (20-in. and 24-in. optional), of the lug-driven type; or genuine "Caterpillar" tractor type crawlers (16-in. standard, 18-in. optional), can be furnished. Both types of crawlers are smooth, non-clogging, and are provided with "recoil" springs. This machine may be quickly converted from one attachment to another without mechanical alteration. Greater mobility is claimed because of the two travel speeds; simple, positive steering, and ample ground clearance. Width and weight are said to be within the limitations of most highway requirements.

New Diesel Tractor

A new diesel crawler tractor—the HD10—has been introduced by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., as a companion model to the HD14. The tractor is powered by the General Motors 2-cycle diesel engine. It has Velve-touch bi-metallic steering clutches and brakes, and "Positive-Seal" truck wheels. The machine is built complete with extra-heavy crankcase, radiator, and truck wheel guards, muffler, hour meter, adjustable radiator shutters, bumper, front pull hook, and electric starting and lighting as stand-



Allis-Chalmers HD-10 Diesel Crawler Tractor



The New Heltzel Heavy-Duty Steel Forms for constructing combined curb-and-gutters. Face forms are removed without disturbing the front and back forms or the division plates — greatly facilitating the hand finishing operations on the face curb. Quick easy adjustments for setting to line and grade. Write today for complete information or quotations and catalog S-20.

• • •

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CONCRETE BUCKETS
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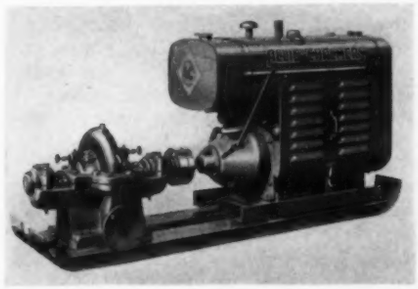
SUBGRADE PLANERS
TOOL BOXES
FINISHING TOOLS FOR CONCRETE ROADS

HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO · U. S. A.

ard equipment. The 4-cylinder engine provides 86 belt horsepower and 71.2 drawbar horsepower with drawbar pulls up to 17,600 lb. The tractor is available in two tread widths, 62 and 74 in., with the narrow model weighing 19,900 lb. and the wide model weighing 20,700 lb. Constant-mesh gears permit shifting on the go like a truck with six speeds forward and two reverse. Because the engine can be throttled down to almost half engine speed without losing drawbar pull, a speed range is provided from 1.58 to 5.67 m.p.h.

New Engine Driven Centrifugal Pump

A line of centrifugal pumps driven by gasoline power units has been brought out by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Power units in five sizes (18 to 110 H.P.) assure economy in operation with a choice of fuels; gasoline, kerosene, distillate, natural gas, or butane. All power units have valve-in-head medium speed engines, with removable cylinder liners, efficient cooling systems, force feed lubrication and a variable speed governor. The

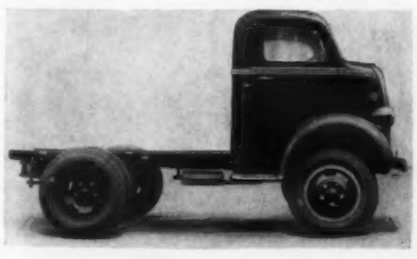


Engine Driven Centrifugal Pump Unit

centrifugal pumps are horizontal shaft, single stage, single or double suction pumps designed for handling liquids at normal temperatures with maximum efficiency. To facilitate handling, the engines and pumps are mounted on a base and are available in many combinations to meet various requirements in quantity and pressure up to 5,000 gal. per minute and 100 ft. head.

New All-Wheel-Drive Truck

A new all-wheel-drive truck has been added to the line of the Marmon-Herrington Co., Inc., Indianapolis, Ind. The unit is a standard Ford 101-in. wheelebase cab-over-engine model, converted to all-wheel-drive in the Marmon-Herrington factory. This model, like all other Marmon-Herrington all-wheel-drives, is equipped with constant velocity joint steering ends, which take the "fight" out of the steering wheel, and provide easy, finger-tip steering control under all conditions. The Marmon-Herrington line now comprises conversions of all standard Ford trucks, passenger cars and commercial cars to all-wheel-drive, and a complete series of "heavy-duty" all-wheel-drive trucks and truck-tractors with gross capacities up to 70,000 lbs.



New Marmon-Herrington All-Wheel-Drive Truck

New Heavy-Duty Trucks

Four new heavy-duty models at rated capacities from 3½ to 7½ tons have been announced by the Federal Motor Truck Co., Detroit, Mich. The new Federal Model 35, rated at 3½-5 tons, is powered with a 6MKRF Waukesha 6 cylinder, 7-bearing engine, 381 cu. in. displacement, 4⅛ in. bore by 4¾ in. stroke, developing 105 H.P. at 2600 r.p.m. Completing the unit power plant is a W. C. Lipe 13 in. single dry plate clutch and a Clark 205V 5-speed transmission. The frame is 10 in. deep. Axles are Timken with bevel drive rear. Hydraulic brakes are amplified by a vacuum booster. The other new models include the 45, rated 4-6 tons; the 55, rated 5-6½ tons; and the 55H, rated 5-7½ tons. All are powered with Waukesha engines, the 6MKRF—381 cu. ft. displacement being used in the model 45 and the 404 cu. in. 6MZRF, in the 55 and 55H models. All of these models also feature a W. C. Lipe 13 in. single dry plate clutch, Clark 270V 5-speed transmission and a 10 in. frame.

MARMON-HERRINGTON
***All-Wheel-Drive* TRUCKS**

Photo, Courtesy Davey Tree Expert Co.

DOING JOBS OTHER TRUCKS CAN'T DO
. . . *IN SCORES OF INDUSTRIES AND FIELDS OF SERVICE*

● Moving large trees, which weigh from five to twenty tons, through swampy ground, creeks, plowed fields and rough woodlands may not be *your* job—but you may have another just as tough.

Like the Davey Tree Expert Co., you may feel that what you need is a "combination locomotive, tug-boat, and mud-hungry tractor." Like them, too, you'll probably find that what you *really* need is a Marmon-Herrington *All-Wheel-Drive* Ford or Heavy Duty Truck!

For, besides giving a lower equipment investment, and materially reduced operating costs, Marmon-Herrington *All-Wheel-Drive* will enable you to tackle hauling jobs you haven't been able to do before.

If your work is road building, or maintenance, snow removal, oil field exploration or transportation, logging, mining or any of a score of services requiring *supreme traction and power application,* these *All-Wheel-Drive* units will pull you through. If you have to haul heavy loads over slippery highways, hills and around treacherous curves, they will cut operating schedules and costs, and provide maximum safety for drivers and loads.

We convert all standard Ford trucks, passenger cars and commercial cars to *All-Wheel-Drive* and build a complete line of heavy duty *All-Wheel-Drive* trucks, with gross load capacities up to 70,000 lbs. Write for literature. Cable address, MARTON, Indianapolis, Indiana, U. S. A.

MARMON-HERRINGTON COMPANY, INC.
INDIANAPOLIS, INDIANA, U.S.A.

Axles front and rear are Timken. The model 45 has a bevel drive rear axle, while the 55 and 55H models have double induction drive.

New Bucket Loader on Pneumatic Tires

A new highly mobile wheel mounted loader has been brought out by the George Haiss Manufacturing Co., 140th St. and Canal Place, New York, N. Y. The new loader is designated as Model 75W and will, it is claimed, handle up to 3 cu. yd. a minute. This gives it capacity to put up a quick load in the big trucks for which its 10 ft. discharge chute clearance was designed. The wheel mounting is on 7.00 x 20 heavy duty tires, with dual wheels in the rear. The front axle assembly and steering gear follows automotive practice and uses standard heavy-duty truck parts. All wheels are on Timken roller bearings, and wheels and tires are interchangeable throughout. Traction drive is from a differential countershaft by roller chain to the rear wheels. The traveling speed of the machine, with the engine governor set for the engine speed used in loading is stated to be 3½ miles per hour; by setting up the governor it is possible to increase this to 5 miles, if moving over a distance. In moving toward the pile, a traction speed of 1½ miles per hour is employed. A low speed crowding drive of 17 ft. per minute

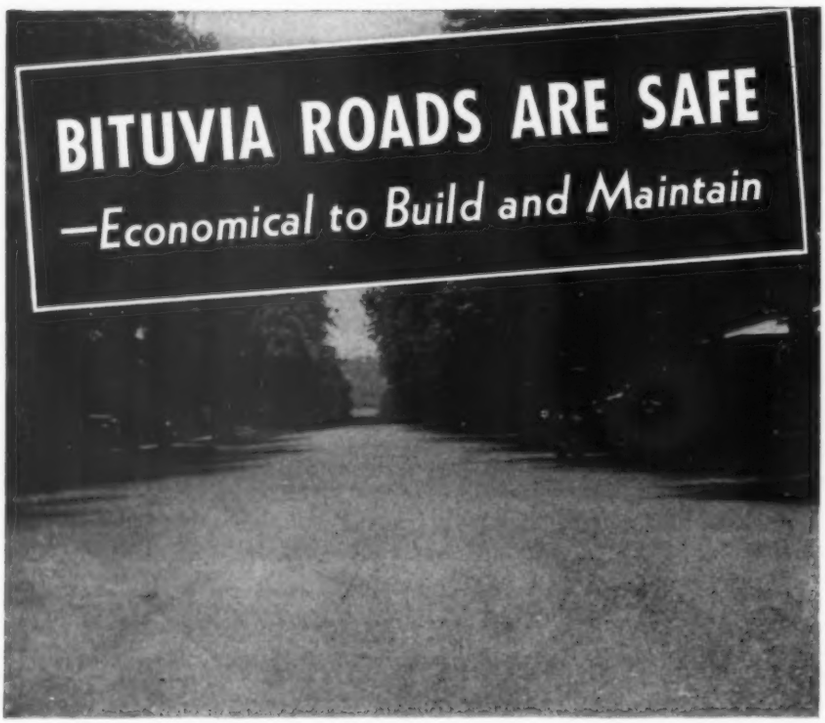
New Haiss Loader on Ohio Job

is also provided. This Model 75W is powered with a 35 H.P. 4-cylinder Waukesha motor driving through a transmission gearset designed and built by Haiss especially for loader service. Heavy, broad faced gears operate at relatively low speeds, and all transmission countershafts are mounted on self-aligning ball bearings. Haiss features the fact that this, like the transmission on other Haiss models, is wholly enclosed, with gears and the compression band clutches through which the elevator and traction drives operate all running in oil. A point is made that dust and dirt tight enclosure cuts down clutch wear and greatly lessens the frequency of clutch take up. The digging-loading mechanism follows traditional Haiss design, with the characteristic revolving-propeller self-feeding device and tooth-edged buckets. A clean-up scraper, hung from the elevator boom is close set behind the feeding peddles and obviates the need for hand shoveling to clean up the ground. The operator is in complete control, raising and lowering the digging end of the elevator through a hand wheel and worm gear mechanism acting on the balance-pivoted elevator. The accompanying illustration was photographed in Ohio when the temperature was 20° F., and the loader was required to break through a 10 in. frozen crust on the gravel pile shown.

Survey Foot-Odometer

A new device brought out by the Speedometer Electric Co., 699 Van Ness Ave., San Francisco, Calif., makes it possible while driving your car to measure distances in terms of feet and to get results closely approaching steel-tape ac-

Survey Foot-Odometer



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The unusual ability of this filler to withstand a wide range of temperatures—from bitter cold to torrid heat—without flow or traffic "pull" in summer, or chipping in winter, makes it an outstanding product. The ease with which it is applied, and the manner in which it holds tenaciously to concrete and brick surfaces characterize this material. Your inquiry will bring you further information about these products.

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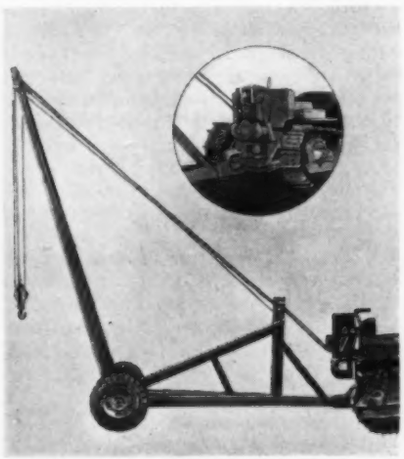
curacy. This survey foot-odometer is calibrated to 1 foot instead of to a hundredth of a mile. It is easily installed on any car or truck and compensations for any inaccuracies in one's speedometer equipment can be made by changing the gear ratio in the dual-adapter which is part of the foot-odometer equipment. The instrument can be disengaged instantly when not in use. The instrument can be mounted in the driver's compartment with either a steering-post bracket or an under-dash bracket and can be operated very easily by the driver.

New Portable Cranes

A new line of portable hoisting cranes has been brought out by the Porta-Crane Corporation, Rapid City, S. Dak. All three models of this Junior line are basically the same in construction and differ only in the accessories which are added. Model A-40, as shown in picture, is intended for use with a crawler type tractor, utilizing the power control unit of the tractor to operate the cables. Model B-40 comes

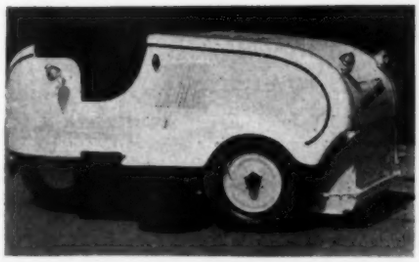


Model A-40 Porta-Crane

equipped with two Beebe Bros. all-steel hand hoists bolted to the frame of the crane, permitting the crane to be operated anywhere, whether attached to a truck or tractor. Model C-40 is a self powered Porta-Crane, and has a small single cylinder air-cooled engine V-belted to a countershaft, allowing power to be applied to either hoist unit. The cranes are of all-steel construction and are arc-welded throughout. A two level hitch allows easy coupling to either a truck or tractor. Choice of single or dual wheels and pneumatic tires. Besides the standard boom length of 20 ft., two other lengths, 25 and 30 ft., can be secured at very little extra cost. All three junior cranes are conservatively rated to lift a maximum load of 5 ton when crane is properly counterweighted with truck or tractor.

New Street Sweeper

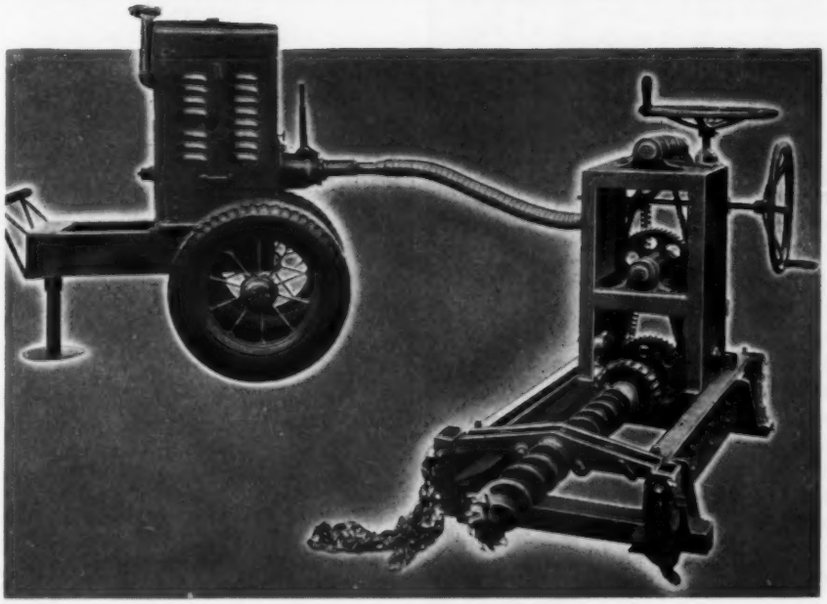
A new pick-up street sweeper, the Gutter Snipe, has been put on the market by the Municipal Supply Co., South Bend, Ind. It has a sweeping width of 5-ft. 6-in. The gutter broom has a diameter of 28 in. and the pickup broom has a diameter of 32 in. and a length of 42 in. The pick-up broom is supported in self-aligning bearings which permit uniform sweeping on uneven or crowned pavements. The suspension of the broom allows the correct pressure on the pavement for most effective sweeping and long life. The gutter broom is large and rugged, enabling it to dig the heaviest accumulations out of the gutter. Pivots to prevent damage if run against curb. The largest hopper, made of rust-resisting steel, measures 1½ cu. yds., and in sweeping it will carry at least ¾-yd. of refuse. Independent hopper control permits carrying a load to any point at high speed for dumping. The sprink-



The Gutter Snipe

ling attachment does not drench the pavement ahead of the broom, but applies a fine atomized spray that lays the dust with-

Parmanco
HORIZONTAL DRILLS



Stop . . . AND THINK!

That cutting pavements causes more damage than traffic.
That trenched yards are eyesores for years.
That public hazard can be eliminated.
That obstructing traffic is not necessary.
That you now can put services in to grade.
That you can save money, time and create good will by using PARMANCO.
PARMANCO Utility Drills are made in two sizes, PARMANCO JUNIOR for drilling 4 inch holes up to 50 feet, and the PARMANCO GENERAL UTILITY for drilling longer distances or drilling larger holes.
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THE MONOTUBE METHOD OF PILE CONSTRUCTION
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154%
AVERAGE YEARLY
SALES INCREASE
PROVES MONOTUBES'
GROWING ACCEPTANCE
● Here's what engineers and contractors really think of the Monotube Method of Pile Construction. From 1935 through 1939, the sale of Monotubes has shown an average yearly increase of 154%!
Why this rapid acceptance?
One—economy of installation. These light, sturdy steel casings are easy to handle, require no core or mandrel, can be driven speedily by any competent contractor with standard equipment.
Two—economy in foundation design resulting from Monotubes' ability to carry greater loads with a high factor of safety.
Three—availability of Monotubes in varying gauges, tapers and lengths to meet a wide range of soil conditions.
Complete information on Monotubes is contained in our Catalog No. 68A. Write for your copy today.
THE UNION METAL MANUFACTURING CO.
CANTON, OHIO

out creating mud. The gutter-snipe machine is equipped with a sturdy 4-cylinder engine having 50 per cent more power available than is actually required for the hardest sweeping. Operator's seat being full width of machine comfortably seats three people, yet the driver sits behind steering wheel at the right hand side in direct view of the gutter broom and curb line, with all controls within easy reach. Steering from the single rear wheel allows greater maneuverability—cutting around parked cars and turning corners—the Gutter-Snipe can turn within a circle 19-ft. in diameter.

New Push-Type Maintainer

A new maintainer, of the push-type drag, has been placed on the market by the Highway Maintenance Equipment Corporation, Fowler, Ind. Some of the advantages claimed for this maintainer include the following: The drag moves along filling the holes ahead of truck, thus providing a level surface for truck and thereby eliminating possibility of cutting new holes or ripples, every time the truck hits a low

New Maintainer

spot. The spreader blade on left side, serves as a mixer and keeps the material from being pushed out in left (on the shoulder drag it keeps the material from being pushed on pavement). The three blades are set at such an angle that they keep pulling the material back on the road and out of the grass "waste line." The operator can raise or lower the device (from inside cab, hydraulic) as he sees fit; if he notices a low spot he can dump the material; if he sees a high spot he can lower the blades and cut it down. The new maintainer is handy for crossing railroad tracks as the driver can taper off and avoid pulling lose material on tracks; it's also handy for approaching bridges, as the driver merely uses the "lift". The maintainer is operated by one man. It is easily attached to any truck, one man only being required to make the attachment. The manufacturer is John C. Johnson, Boswell, Ind. It will be manufactured in three sizes: for gravel roads, for stone roads and for shoulder maintenance on paved highways.

New Air Hose for Pneumatic Tools

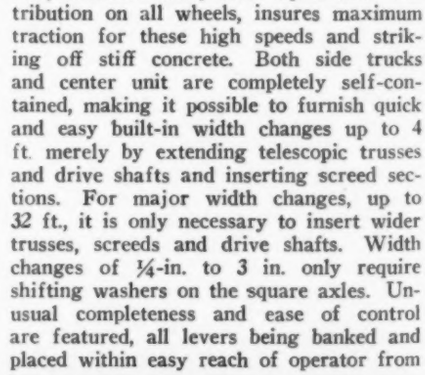
A new air hose designed especially for heavy duty pneumatic tool service has been introduced by the Mechanical Goods Division Goodyear Tire & Rubber Co.,

Red Wing Air Hose

Akron, O. The tube is of non-porous rubber, resistant to action of hot and cold air. Lubricants in the air will not cause swelling or flaking, obviating clogging of tools with rubber particles. Reinforcement is provided with three plies of multiple-braided, special cabled cotton yarn, providing a high safety factor for working pressures and high resistance to blows and impacts. The cover is a heavy gauge of soft red rubber with a high tensile strength, providing utmost resistance to cutting from rocks, ore, or other materials. It likewise is abrasion and sun-resistant. A product designed with quality the first consideration, Red Wing air hose is available in ½-in., ¾-in. and 1-in. sizes.

New Finisher

A Type "H" de luxe finisher, designed to keep pace with 34-E dual drum pavers and Jaeger screw spreaders on any width of slab, has been announced by The Jaeger Machine Co., Columbus, O. One heavy duty, automotive-type transmission, with working speeds up to 18 f.p.m. and traveling speeds up to 100 f.p.m., performs all transmission functions. Smooth, positive, 4-wheel drive, with equal load distribution on all wheels, insures maximum traction for these high speeds and striking off stiff concrete. Both side trucks and center unit are completely self-contained, making it possible to furnish quick and easy built-in width changes up to 4 ft. merely by extending telescopic trusses and drive shafts and inserting screed sections. For major width changes, up to 32 ft., it is only necessary to insert wider trusses, screeds and drive shafts. Width changes of ¼-in. to 3 in. only require shifting washers on the square axles. Unusual completeness and ease of control are featured, all levers being banked and placed within easy reach of operator from



Type "H" De Luxe Finisher

front or rear. Screed speeds are controlled independent of traction when gears are shifted but synchronized with changes of speed by throttle. Screeds are driven by spring-cushioned connecting rods to eliminate jerking and lifted separately or simultaneously by fast hydraulic power lift operated by direct driven pump and may be operated slightly raised for first pass over dry material. Design of screeds is box-type, fully enclosed with two rows of crown adjusting studs, one row across front, the other across rear of screed bottom to insure against warping and provide simple means of putting positive tilt into screed shoe. Improved quick crown change screed, which requires movement of only one lever to change crown overall, can be furnished. For vibratory concrete, the finisher can be equipped to operate with either vibratory tube or vibratory motors mounted direct on bull-nose front screed to insure deep, internal vibration of the material.

New Excavator

A new excavator has been added to the line of The Osgood Co., Marion, O. This Type 90 is a rugged, heavy duty excavator. It is available as a shovel, with varying lengths of booms and handles and dippers up to 2½-yd. capacity, and with dragline equipment up to 85 ft. boom and 2 yd. bucket, with larger buckets on shorter booms. Main deck casting is a large, unit steel casting, with all machinery mounted

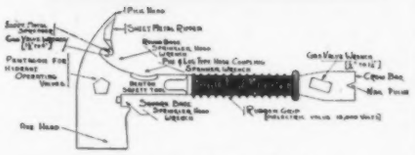
Osgood Type 90 Excavator

in unit cast steel side frames, carried on machined pads. Side frames keep all shafts and gears in perfect alignment. The machine is powered by gas, oil, diesel, or electric motor. Power is transmitted from the engine or motor to the countershaft by a fully enclosed Morse silent chain. Power take-off clutch is of disc type. Swing and travel gears are ball bearing mounted, and controlled through wide faced, large diameter contracting band clutches. The crowding and retract unit is self-contained and bolts to the main deck casting.

Hoisting drum assembly has wide faced spur gears, machine cut from blanks. The drum shaft is extra heavy, and is anti-friction bearing mounted. Drums are cast steel with demountable semi-steel lagging for various classes of work. Clutches are set by Osgood "Servo Mechanism." Machinery is so arranged on the deck that it is easy to get at and to make adjustments. All controls are led to the left front of the cab. Swing and travel clutches, and swing brake are controlled by Osgood "Vacuum Control."

A Tool of 101 Uses

With the above illustrations very little need be stated in words to convince one of the more than 101 uses to which such an instrument as the Benton Safety Tool can be put. This unique tool, developed by Benton Tool Corporation of Cleveland. O., is manufactured from high carbon steel and then chrome plated. It is 18 in. long, overall, and the sure grip handle and safety heel is rubber "plated" for protection against electric shock up to 12,000 volts. The axe blade is a real one and the pick head has a ⅜ in. chisel point.

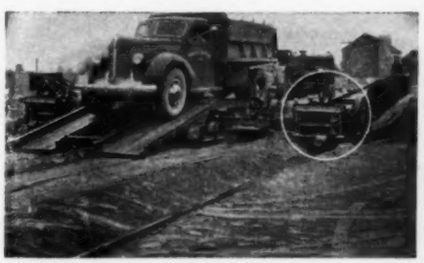


Benton Safety Tool

The tools weighs 3¾ lbs. and a specially designed holster is available for wearing attached to the belt. For descriptive folder and price write Benton Tool Corp., 425 Engineers' Building, Cleveland, O.

Improvement in R. B. Power Finegrader

The Buckeye Traction Ditcher Co., Findlay, O., has announced a recent engineering improvement in the R. B. power finegrader. This consists of a relocation of the form wheels (in effect, a lengthening of the wheel base so that it is longer than a standard road form section) in order that the weight of the finegrader will, at all times, be supported by *two* form sections on each side of the grade, four in all. This design change prevents the total weight of the machine from bearing, at any time, on only one form section on each side of the grade, thus eliminating any possibility of the load



R. B. Power Finegrader

5 WAYS TO CUT DRAFTING TIME and EXPENSE

- Here's how OZALID TRANSPARENT papers, cloths, and foils provide short cuts in drafting practice and reduce costs.

1. DUPLICATE ORIGINALS ON TRANSPARENT PAPER, CLOTH OR FOIL FOR BRANCHES OR CUSTOMERS . . . made in the same simple manner as standard Ozalid Whiteprints.
2. TRANSPARENT DUPLICATES WITH CHANGES FOR SPECIAL PURPOSES WITHOUT ALTERING ORIGINAL DRAWING . . . produced by deleting detail and making additions on the duplicate. Standard Ozalid Whiteprints incorporating these changes are made from these transparent duplicates.
3. OLD, SOILED OR WORN TRACINGS . . . reclaimed and weak pencil lines intensified with Ozalid foil which can be cleaned to eliminate spots, blotches and crease marks.
4. COMPOSITE PRINTS . . . accomplished by bringing the details of as many as six originals together into one Ozalid Whiteprint by the use of Ozalid foil.
5. WHITEPRINTS . . . made from inexpensive Ozalid transparent duplicates, while valuable originals are stored safe from fire, wear, and tear.

ONLY OZALID HAS DRY DEVELOPMENT

Ozalid CORPORATION
ANSCO ROAD · JOHNSON CITY, N. Y.

OZALID CORP. 42-4
Ansco Road, Johnson City, N. Y.
Please send full information on how Ozalid transparent materials cut drafting costs, and free booklet of dry-developed Ozalid prints.
Name_____
Company_____
Street_____
City_____ State_____

forcing the forms out of vertical alignment at the joints.

New Units for Traffic Signal

Several new items for traffic signals have been added to the line of The Kneisley Electric Co., Toledo, O. These include a flasher pack for modernizing old out-of-date traffic signals; a portable emergency "stop" signal, and a new type amglo bulb for "stop" and "go" traffic signals. It is claimed this bulb replacing the ordinary 50-watt incandescent lamp, will produce an equal amount of light and use only 13 watts, effecting savings in power costs alone of 70 per cent, plus a saving in maintenance costs due to the long life (up to 10 years) of the bulb.

Paint Brush Preserver

A container in which to preserve paint brushes has been placed on the market by Yenne & North Mfg. Co. P. O. Box 362, Worcester, O. It consists of a metal box approximately 11 in. x 12 in. x 14 in., weighing 25 lbs, equipped with separate compartments, which are to be used in suspending brushes of various lengths and widths. One compartment is used for catching the surplus paint and other liquids when wishing to clean the brush, before and after using. Installed in the waste compartment, is a wringer, consisting of two rollers, easily operated by a slight touch of the fingers, which, by placing the brush between the rollers and drawing same upward extracts the surplus paint from the brush after being used, or the preserving fluid before using. Clips are so arranged over each compartment with small pegs from which to suspend one or more brushes of various widths and lengths in each compartment, containing a preserving fluid such as linseed oil. This preserving fluid is placed in each separate compartment to a certain level, and the brushes are suspended to a depth in the oil or fluid depending on the length of the bristles. It is stated that this preserver does away with the necessity of cleaning brushes when out on the job when leaving over night or for greater periods of time.

WITH THE MANUFACTURERS

John E. Carroll Appointed Manager Chicago Office, American Hoist & Derrick

John E. Carroll has been appointed manager of the Chicago office of the American Hoist & Derrick Co., St. Paul, Minn. For several years Mr. Carroll had charge of the Southwestern offices of the company. The Chicago office is located at 208 West Washington St. John L. Hickey will be Mr. Carroll's right hand man in the office.

George R. Huffman Resigns from LeTourneau

George R. Huffman, for the past three years advertising manager of R. G. LeTourneau, Inc., Peoria, Ill., manufacturers of heavy grading equipment, resigned March 15 to return to the Pacific Coast.

Yeagley Appointed Distributor for Osgood

J. W. Yeagley, 1828 Bissonnet St., Houston, Tex., has been appointed distributor for The Osgood Co., Marion, O. Mr. Yeagley's territory will cover the southern half of Texas. He will represent the full line of Osgood excavating and material handling machinery, ranging in size from ⅜ to 2½ cu. yd.

Link-Belt Speeder Corporation Opens New York Office

Troy M. Deal, president of Link-Belt Speeder Corp., Chicago, Ill., announced the opening of a New York office at 856 East 136th St., to handle the sales and service of Link-Belt Speeder shovels—draglines — cranes. The phone number is MELrose 5-5096. This location is the building of the Clyde Iron Works, a company that now handles the ale of the heavier type (1½ to 2½ yard) of Link-Belt Speeder machines in the industrial field of the New York area. E. H. Kliebenstein, well known in the construction and building trade, will be in charge of the new office.

T. M. Deal

R. B. George Machinery Co. and R. B. George Tractor & Machinery Co. Appointed Bucyrus-Erie Distributors for Northern Texas

The R. B. George Machinery Co. of Dallas, Tex., and the R. B. George Tractor and Machinery Co. of Amarillo, Tex., with branches at Tyler, Abilene, and Lubbock, have been appointed distributors in the northern half of Texas for Bucyrus-Erie ⅜ yd. to 2½ yd. shovels, draglines, clamshell and lifting cranes. By adhering to a definite policy of supporting their sales with the finest service, the R. B. George Machinery Co. and the R. B. George Tractor and Machinery Co. have built up in the 24 years of their existence one of the largest road machinery businesses in Texas. Customers and prospects for Bucyrus-Erie ⅜ to 2½ yd. machines in the Southern half of Texas will continue to be served by the Gulf Tractor & Equipment Co., Houston, and Tri-State Equipment Co., El Paso. And all Bucyrus-Erie distributors in Texas work with the

TRAFFIC FOLLOWS the ROLLER

When you select the Improved Colprovia Cold-Laid Dense Asphalt Paving Mixture designed for

STABILITY *immediately after* COMPACTION

OTHER COLPROVIA PROCESSES

Cold mixed materials for Stockpile and Maintenance; lasting workability without volatiles or emulsions. Semi-hot-mixed cold-laid mixtures for resilient Playground and Game Court surfaces. See your local Colprovia manufacturer, or write:

COLPROVIA ROADS, INC.

Laboratory
801 2nd Ave.
New York, N. Y.

Office
183 East Main Street
Rochester, N. Y.

cooperation of E. B. Chambers, Bucyrus-Erie representative in Dallas.

Charles E. Steffey Appointed President Prismo Safety Corp.

Charles E. Steffey has been appointed president and general manager of the Prismo Safety Corporation, Huntingdon, Pa. Mr. Rodli will continue as vice president and assist Mr. Steffey in carrying out an aggressive sales campaign. Mr. Steffey was formerly with the National Cash Register Co., where he started at the bottom and through innate ability and application to duty worked himself up to the high position of vice president, director and general sales manager, which position he held for 16 years.

Harold G. Smith Appointed Chief Engineer Engine Division of Buda

Harold G. Smith has been appointed chief engineer of the Engine Division of the Buda Company, Harvey, Ill., according to an announcement just released by Mr. R. K. Mangan, vice-president. Mr. Smith has for several years been associated with the internal combustion engine industry. Among other societies, Mr. Smith is a member of the S. A. M. E. and is also a member of the Engine Standards Commit-tee of the Society of Automotive Engi-neers.

H. G. Smith

Over 2,500 Attend Penn Machinery Show

More than 2,500 invited guests attended the "Get Together" equipment show of H. O. Penn Machy Co., Inc., held at the Bronx Headquarters of the company, 140th St. and East River, New York City. Included in this turnout were many contractors, city, county and state highway officials, engineers, builders, operators, industrial plant owners and managers, as well as a surprising number of seamen, the latter intensely interested in conversion to heavy duty and lost cost marine diesel power.

Over 25,000 sq. ft. of the Penn show rooms were devoted to exhibits of the equipment handled by this well known distributor. There was generous aisle space in which to move about comfortably even when the peak of visitor count was reached. The smaller displays were well placed and so arranged as to permit inspection from all angles by guests, all of whom seemed vitally interested in studying and earnestly discussing the equipment they had come to inspect. For this was not a crowd of passerbys. Not a line of publicity was released before the show and the full attendance was by invitation only. Many guests including those from New Jersey and upper New York devoted the whole day to the show.

The "Get Together" was scheduled from 4 P. M. to 11 P. M. according to the tickets but the crows began filing in shortly after 12 noon and it was past midnight before the hosts had time to think of curfew. Steak sandwiches by the thousands with barbequed ham or swiss cheese thrown in for variety were served during the dinner hour and far on into the night. Delicious clam broth, hot coffee and many kegs of beer added to the pleasure of the "Get Together."

Prizes were awarded by drawings conducted by Mr. Penn. Nick Palumbo of Tuckahoe, N. Y. won first prize, a leather traveling bag. Ben Anderson, now with the World's Fair Corporation took second prize, a portable radio. Third prize went to Harry Rubins, who is now the proud possessor of a very handsome leather jacket. R. Peinecke of Jamaica won fourth prize, an electric razor, and Frank Giordano, operator for the Firmbilt Construction Co. took the fifth prize of a Waterman pen and pencil set. In keeping with the Penn reputation, there were prizes of some kind for everyone. Automatic pencils, calendars, special file folders of condensed information on the Penn line, note books of "Things to Remember" about the Show, and other attractive advertising novelties were available.

The H. O. Penn Machinery Co. was established in 1921 and the business has grown steadily year after year through periods of depression and panic until now it is one of the largest distributing and servicing organizations in the world, with three plants cooperating but independently operated. The company is staffed by many of the industry's leading figures and is headed by Hamilton O. Penn, a name that is favorably known throughout the country. The Penn organization acts as exclusive territorial representative for many nationally known products including "Caterpillar tractors, marine engine, power units;

View of Portion of Showroom

WILLIAMS LEADS IN WELDED BUCKET CONSTRUCTION

Williams Buckets have always featured more welding in bucket construction than any other manufacturer.

NOW, IN THE NEW 1940 LINE OF WILLIAMS BUCKETS,

welded rolled steel construction is utilized in every feasible part. Sections which take the hardest blows or endure the greatest wear are built up by welding in special alloy steels.

STRONGER! LESS BREAKAGE! LESS WEAR!

Williams Buckets and parts are carried in stock for prompt deliveries and service by distributors in all parts of the country.

THE WELLMAN ENGINEERING CO.
7003 CENTRAL AVE., CLEVELAND, OHIO

WILLIAMS *Buckets* **built by WELLMAN**

Kinney

BITUMINOUS DISTRIBUTORS

When you purchase a Kinney Distributor you get a machine that measures bitumen accurately on to the road surface; simple piping, simple, easily operated controls; pump, engine, and valves easily accessible for proper care by the operator; good weight balance to cut your tire expense; and important safety features.

Write for Bulletin A 1940 — learn why those who know buy Kinney; (they have been since 1910!) — address, Kinney Mfg. Co., 3537 Washington Street, Boston, Mass.

Kinney

IT'S RESULTS THAT COUNT

A BURCH UNDR-TRUK-MAINTAINER will reshape and put in good condition more miles of road per day than any other. More than that, it is economical, using for power the truck you now own.

Can be attached to or taken off truck in five minutes and does not tie up truck from doing other work.

THE BURCH CORPORATION

Crestline, Ohio

Manufacturers

Maintenance Equipment, Dump Bodies, Hoists, Conveyors, Stone Spreaders

Marion shovels; LeTourneau scrapers; Athey wagons; LaPlant-Choate bulldozers; Huber roller; Foote pavers; Smith mixers; Heltzel bins and forms; Marlow pumps; LeRoi compressors; Beach saw rigs; Owen buckets and Speeder shovels.

Garfield & Co. Appointed Distributor for Lima

Garfield & Co. of which G. A. Garfield is the head, has been appointed distributor for Lima Locomotive Works, Incorporated, Shovel and Crane Division, handling a complete line of Lima shovels, draglines and cranes. Headquarters for Garfield & Co., are in the Hearst Bldg. in San Francisco. This company has been organized since 1915 and has continuously served the construction and mining industries since that time. They have developed an efficient sales and service organization trained to give the contractor and miner the best service available. The Garfield organization maintains in addition to its headquartres office, adequate warehousing and service facilities in San Francisco.

H. B. Loxterman Is Dead

Howard Benjamin Loxterman, 57, a vice president and director of Blaw-Knox Co., Pittsburgh, Pa., died March 28 at his home, 407 Glen Arden Drive, Pittsburgh, following an extended illness. Mr. Loxterman was connected with the Blaw-Knox Co. since its formation 34 years ago. Entering its employ as a draftsman in 1906, he was soon placed in charge of design and fabrication of steel forms. His next advancement was as manager of service, following which he was appointed sales manager of the company's Blaw-Knox Division. He was elected secretary and a director of the company in 1934, and in the same year was elected a vice president.

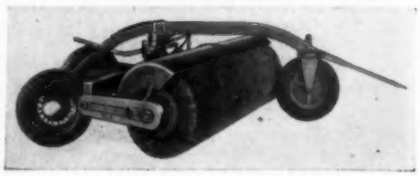
R. B. Loxterman

Fletcher and Farley Elected Vice-Presidents of Caterpillar Tractor Co.

J. D. Fletcher, Export Sales Manager, and T. R. Farley, Assistant to the President, have been elected vice-presidents of Caterpillar Tractor Co., Peoria, Ill. Mr. Fletcher will continue as head of the export department, the position which he has held for the past ten years, and in which he gained wide recognition in the field of international trade relations. He is a director of the National Trade Council, Inc. Mr. Fletcher was born in Pasadena, Calif., where he received his early schooling. He graduated

J. D. Fletcher

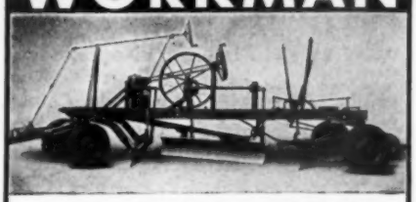
Grace
Two-Way Road Sweeper



Also the Rapid Fire Car Heater for Asphalt

W. E. GRACE MANUFACTURING COMPANY
6000 Holmes Street
DALLAS, TEXAS

MASTER WORKMAN



For Better Roads, put a WORKMAN Machine on the job. 3 sizes:
THE GENERAL • THE SUPER
THE MASTER

YORK MODERN CORPORATION
UNADILLA, NEW YORK

Reliance—
CRUSHING
SCREENING and
WASHING UNITS

● UP TO 2000 TONS A DAY ●

Crushers	Bins	Drag-Lines
Elevators	Pulverizers	"GAYCO"
Screens	Feeders	Centrifugal
Sweepers	Spreaders	Air Separators
Wash Boxes	Kettles	
	Conveyors	

UNIVERSAL ROAD MACHINERY CO.
Kingston, N. Y.
Canadian Representatives: F. H. Hopkins & Co., Ltd.
340 Canada Cement Co., Montreal, Que., Can.

WALKER BAR
No Drip!
FULL CIRCULATING
★ SPRAY BAR for ALL ★
BITUMINOUS DISTRIBUTORS
Easy to Install
WRITE FOR CIRCULARS
THE EARL WALKER CO. INC.
SULLIVAN, ILLINOIS

CORNETT SLOPER
Bank Sloping Revolutionized!
SPEED EFFICIENCY

• Slopes banks rapidly.
• Easily attached to any shovel in an hour's time.
• Will cut any slope that a shovel can dig through.
• Controlled entirely from operator's seat.
• Will cut through sand, gravel, soil, clay and broken rock in one operation.
See your dealer or write for further details
CORNETT SLOPER
607 DeGraw St. Brooklyn, N. Y.

Your Gracious Host.. From Coast to Coast
In NEW YORK..

The Gotham
In CHICAGO..

The Drake
The Blackstone
In LOS ANGELES..

The Town House
In BELLEAIR, FLA..

Belleview Biltmore
KIRKEBY HOTELS

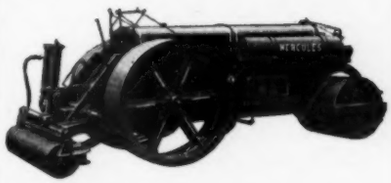
from the University of California with a Bachelor's Degree in 1907, and obtained a Master's degree two years later. In 1910, after a year at the institution in connection with university extension work, he engaged in the shipping business. From that occupation he was drafted during the War into the Marine Transportation Division of the Food Administration in Washington. He was also associated with the Commission for Relief in Belgium, and the American Relief Administration, both in Washington and New York. After the Armistice, he helped form an Export company in New York, and for five years participated in its rapid growth. June 1st, 1929, he entered the employ of Caterpillar Tractor Co., and the following year was made export sales manager. Mr. Farley, who is abroad studying export markets at the present time, will retain his numerous administrative duties. Born in Ipswich, Mass., he was educated in eastern schools, specializing in engineering. Upon graduation, he went to work for the New England Telephone & Telegraph Co., and later for the Pierce-Arrow Motor Car Co. In 1916, he enlisted in the United States Army, and saw active service during the World War. When he received his honorable discharge in May, 1919, he was a captain. In June of that year, he went to work for The Holt Manufacturing Co., one of the predecessors of Caterpillar Tractor Co. When the present company was formed, he continued as an employee, and rose steadily to his position as Assistant to the President.

T. R. Farley

John V. Jirasek Joins Worthington

John V. Jirasek has recently joined the Worthington Pump and Machinery Corporation, Harrison, N. J., as a special representative to the petroleum and chemical industries. Mr. Jirasek is a graduate in chemical engineering from the University of Prague and did post graduate work at the Sorbonne in Paris. A citizen of the United States Mr. Jirasek has, in the past 20 years, both in the United States and in Europe, been engaged in research, experimental and development work with leading firms in the petroleum field. Recently Mr. Jirasek was associated with the Compagnie Technique Des Pétroles, European representative for the M. W. Kellogg Co. and with the Sharples Corporation of Philadelphia, just prior to which he was connected with E. B. Badger & Sons Co. in charge of their European business. Mr. Jirasek will make his headquarters at Worthington's general offices in Harrison, N. J.

J. V. Jirasek

HERCULES

DEPENDABLE ROAD ROLLERS
The Two-in-One Roller with Interchangeable Hydraulic "Ironeroll" and Scarifier.
6 to 12 Ton
Gas or Diesel
THE HERCULES COMPANY
MARION - OHIO

CUMMER
...the dependable line of asphalt paving machinery
• Portable Combination Hot and Cold Mix Plants
• Portable Hot Mix Plants
• Stationary Combination Hot and Cold Mix Plants
• Cummer Combination Dryer-Coolers
• Steam Jacketed Mixers 400 to 8000 pounds capacity
• Cummer Internal Fire Dryers
• Electric Batch Timers
• Cummer Automatic Asphalt Meters
The F. D. Cummer & Son Co.
Euclid at 17th Cleveland, Ohio

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CLEARING HOUSE

WANTED—MUNICIPAL EQUIPMENT SALES AGENTS

To sell on liberal commission basis—Street Signs, Traffic Signs, Reflector Signs, Signals, Parking Meters, etc.

MUNICIPAL STREET SIGN CO.
777 Meeker Ave. Brooklyn, N. Y.

FOR SALE

1—¾ yd. Bay City Heavy Duty Shovel.
1—40 ft. heavy duty boom.

CLIFFORD WATERHOUSE
1000 E. Mississippi St. Jackson, Miss.

FOR SALE
USED EQUIPMENT

10x20 DIAMOND Roller Bearing Jaw Crusher
10x36 " " " " "
15x36 " " " " "
2'0"x4'0" single deck DIAMOND vibrating screen
6 to 8 HP model MRP3 LaNel Engine
Model No. U-40 Allis-Chalmers Engine
4" Sterling Sand Pump No. 3558
6¾"x20'0" Revolving screen—Structural frame on wheels

NEW EQUIPMENT

1—DIAMOND 9x16 Bronze Bearing Jaw Crusher mounted on truck with 15-20 HP engine
3'0"x8'0" Triple Deck Diamond Vivrating Screen
21-Cu. Yard Jack Leg Bin
Special Price for quick sale.

DIAMOND IRON WORKS, INC., AND MAHR MANUFACTURING CO., DIV.
Minneapolis Minn.

WANTED

Representatives to handle the sale of a line of power graders, gravel plants, asphalt plants, rock crushers and other road building machinery. Box 444, Roads and Streets, 330 So. Wells St., Chicago, Ill.

Chicago Testing Lab., Inc.
and affiliated
Chicago Paving Laboratory, Inc.
Consulting and Inspecting Engineers
HUGH W. SKIDMORE GENE ABSON
Materials, Processes, Structures, Consultation, Inspection, Testing, Designs, Research, Investigations and Experts in Litigation.
536 Lake Shore Drive Chicago